

# **Attributes of a sustainable transition for the traditional manufacturing sector in regions of Australia**

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A thesis submitted in partial fulfilment of the requirements for  
the degree of Doctor of Philosophy

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Economics



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Submitted for examination, June 21<sup>st</sup> 2018

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# Thesis Summary

In the context of general accelerating change, the World Environment and Development Commission defined 'sustainable development' as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (World Environment Development Commission 1987). As a consequence, sustainable transitions research has been undertaken since the early 1990s. Studies have investigated fundamental changes (such as technology, organisations, socio-economic) in systems (products, services, structures) towards more sustainable, social and environmental alternatives. Such a rich body of work focuses on long-term, multi-dimensional and fundamental transformation processes through which established socio-technical systems shift to more sustainable modes of production and consumption.

This form of enquiry has increased rapidly and constitutes a field of research that is of high societal relevance, given the sustainability challenges the world is facing today. Although broadening its scope over the last decade, much of the sustainable transition research currently has limited relevance outside Europe or energy and urban centred domains and has not, to date, considered the elements of a transition within traditional manufacturing in Australian regions. This study aims to develop an innovative integrated model to enable the identification of sustainable transition attributes across the traditional manufacturing sector in regions of Australia.

The interdisciplinary theoretical framework 'Attributes of a Sustainable Transition' integrates four existing conceptual approaches (i.e. Advanced Manufacturing, Sustainable Transitions, Regions are Spatial and Transition Regions) in order to generate new ways of identifying the characteristics of transitions. Empirical analyses of the first two concepts of the Attributes of a Sustainable Transition identified, across 24 traditional manufacturing firms in regional Australia, that where the manufacturing regime is secure and stable, firms struggle to reshape existing systems. Where destabilisation has commenced through business model innovation, collaboration, knowledge absorption and strategic visioning, a reconfiguration towards sustainability is more likely to be underway.

To address the general lack of empirical evidence as to how and where specific transitions take place in particular city regions, an Evolutionary Economic Geography approach has been used to explore the

uneven spatial landscape of transition example. This approach looks at why industries concentrate in space, how networks evolve in space, why some regions grow more than others and how institutions co-evolve with industrial dynamics in regions. Comparative case study analyses of three city regions, demonstrated that a Replication Strategy (e.g. replicating existing capabilities based in related activities, duplicating existing knowledge or experience) exists in each region as a result of cognitive, functional and political influences. In addition, an Exaptation Strategy (e.g. promoting manufacturing knowledge and technology to create new sustainable niche-innovations in related sectors) existed in two city regions and a Transplantation Strategy (e.g. developing an industry, unrelated to its knowledge base and institutions) exists in one city region.

Finally, to examine the interfirm customer-supplier relations that influence sustainable transitions within the manufacturing sector, a ‘systems’ oriented socio-technical assessment was completed. Four sustainable-technology customers with headquarters in Australia demonstrate a range of attributes that are essential for stimulating a manufacturing supply chain shift towards sustainable market-niche innovation and collaboration. Significant findings include the range of dynamics that trigger and challenge a transition of the firm, reinforcement that the concept of sustainability remains a singular compartmentalised feature of change, rather than a component of a systematic sustainable and innovative transition.

Taken together, the results of the empirical analyses demonstrate that the ‘Attributes of a Sustainable Transition’ hypothesis makes a valuable contribution in identifying the sustainable transition attributes of the traditional manufacturing sector in regions of Australia. An overall implication of the thesis is that while each empirical investigation contributes to the attribute identification process, each inquiry also highlights the complexities inherent in system structures that cannot be solved with ‘one size fits all’ solutions. Solving this problem requires a transition towards adopting systems thinking and action. The process of transition, within each firm, has significant implications in terms of the creation of new value chains, niche innovation and global production networks.

## Statement of Originality

I certify that the work of this thesis entitled ‘Attributes of a Sustainable Transition for the traditional manufacturing sector in regions of Australia’ has not been previously submitted for a degree to any other university or institution.

All work related to this research study has been carried out by myself under the supervision of Professor Raymond Markey and Associate Professor Louise Thornthwaite. I was solely responsible for the design of the research, data collection, analysis and write up of all chapters within this thesis. Professor Raymond Markey and Associate Professor Louise Thornthwaite provided guidance and review feedback on each chapter.

Macquarie University Ethics Committee approval was obtained for all aspects of the research studies presented in this thesis (Reference No: 5201500130).

Katrina Skellern \_\_\_\_\_

Date \_\_\_\_\_

## Acknowledgements

I am so glad to have this opportunity to thank everyone who has supported me on this doctoral journey. First, I would like to express special appreciation to both my Principal Supervisor, Professor Raymond Markey and Co-Supervisor, Associate Professor Louise Thornthwaite. To be given the opportunity to concentrate on a PhD topic for a full-time three year period, has been both an honour and a privilege and would not have been possible without the two of you. Your ongoing belief and confidence in me throughout this time encouraged me to contribute to a research issue I feel strongly and passionately about. Your patience and tireless reviewing of my writing style paid off in the end!

Second, I would like to acknowledge and give special thanks the research participants who opened their doors and donated precious time to offer a rare insight into the opportunities and challenges they face in navigating a new manufacturing future. I hope the content of this thesis can assist in some way towards achieving your goals. To the regional industry stakeholders who believed in my research aims and entrusted me with their local knowledge and networks, thank you.

Third, my sincere thanks to my PhD Writing Group who, whilst meeting only occasionally to discuss and review each other's manuscripts, will never know how valuable it was to me to have such wonderful inspiring peers with whom to exchange ideas, laughter, frustration and confusion. I wish you all luck with your post PhD journeys. Fourth, thank you to all the people I have met along the way – at conferences, workshops and online transition networks – who provided me with much advice and scholarly knowledge that has been invaluable, now and for years to come.

Finally, thank you to my family and friends, who reminded me that I can have a life, despite the constant pull to the computer, and still get the job done! To my husband who halved his precious shed to build me an office, so I had a space to write and seek quiet – I could not have done it without you. Thank you.

# Chapter 1 – Introduction

Manufacturing has been a key contributor to economic growth in developed economies since the industrial revolution. However, during the last two decades, the sector has undergone a significant shift. Large developing nations began to compete with established markets where traditional manufacturing models once dominated. New technologies were introduced that automated jobs and expertise. Demand for products dropped due to a recession in parts of the world and changing consumer preferences. The impact of climate change and limits to finite resources began to take effect, and manufacturing employment fell.

The traditional manufacturing<sup>1</sup> sector is largely comprised of heavy engineering, materials and machinery production firms. Some of the world's most polluting industries are manufacturers, and some argue, are notorious for leading the 'race to the bottom' through low-technological incremental change and low value production (Green and Roos 2012). The new context presents complex issues for manufacturing firms and industrial regions in generating an alternative pathway from the 'old' high volume carbon economy to a 'new' advanced sustainable one.

This challenge is recognised by both business leaders and policy makers, who can no longer rely on old responses to address a new manufacturing future (McKinsey Global Institute 2012). The European Union's Climate Policy, the Paris Climate Change Agreement and the United Nation's (UN) Sustainable Development Agenda, all call for greener production and new ways of producing economic growth (Schot and Steinmueller 2002). For example, the United Nations General Assembly (2015) published 17 Sustainable Development Goals, three of which directly and indirectly involve the manufacturing sector in achieving such a transformation:

- Promote inclusive and sustainable economic growth, employment and decent work for all,
- Build resilient infrastructure, promote sustainable industrialisation and foster innovation, and
- Ensure sustainable consumption and production patterns.

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<sup>1</sup> In this context, manufacturing refers to the transformation of a tangible, material product (initially gathered from the natural environment) into something more complex and useful (Stanford 2016).

In Australia, the manufacturing decline in output and employment activity mirrors the global scenario, with production comprising just 6.0 per cent of gross domestic product (GDP) in 2015 compared to 29.0 per cent 50 years ago; and the current manufacturing share of the Australian economy continues to shrink (Office of the Chief Economist 2016). Existing models of manufacturing are still largely based upon the mass production and consumption eras of the 20<sup>th</sup> Century, with sustainability seen as a cost, something that would be good to do for the environment, rather than a fundamental component of ‘doing business’.

Nevertheless, in advanced corners of the globe, manufacturing remains an essential foundation for innovation and competitiveness, contributing significantly to research and development, skills and capability growth, international trade and a lower carbon society. Qian (2014) advocates that sustainable manufacturing combines production efficiencies and ecologically sensitive design, leading to renewed prospects along the value chain as consumers increasingly look to buy environmentally friendly produced goods. Consequently, manufacturers who can adapt processes and products to the needs of a sustainable economy will have a competitive advantage, while at the same time supporting a sustainable future (Skellern, Markey and Thornthwaite 2017).

To date, much of the research on sustainable manufacturing models has been undertaken outside Australia and mainly within a European setting where global climate policies have been ratified and action taken to support change. Against this background, this thesis will *identify attributes of a sustainable transition for the traditional manufacturing industry sector in regions of Australia* by addressing the following research questions:

- What are the attributes of a sustainable transition for the traditional manufacturing firm and industry sector in Australia? (Chapter 4)
- What are the attributes of a sustainable transition for the traditional manufacturing region in Australia? (Chapter 5)
- What is the role of the ‘customer’ (original equipment manufacturer) in influencing a sustainable transition of the traditional manufacturer in Australia? (Chapter 6)



For the purpose of this research, an attribute can be described as a positive or negative characteristic of an object (person, firm or thing) (Babbie 2009). In pursuit of a sustainable transition, an attribute entails ‘a change (technologies, institutions, organisations, social, economic) of manufacturing systems (products, services and structures) towards environmental and social sustainable alternatives’ (Geels 2011, p.25).

Sustainable transition research includes a number of theoretical frameworks and models that have predominantly explored transformational change across specific industry sectors incorporating transportation, energy and water. During this time there have been limited attempts to draw approaches together to identify elements and attributes that stimulate a systematic transition of the traditional manufacturing sector. This thesis contributes towards investigating a manufacturing transition, from its origin of conventional production towards a future of innovation and sustainable path creation. By developing an integrated interdisciplinary theoretical model that combines four existing conceptual approaches, this thesis will identify and analyse the socio-technical system factors that contribute to a transition of the traditional manufacturing firm in regions of Australia.

This introductory chapter, commences thesis sequence (see Figure 1.1) by exploring the need and associated challenges of a sustainable transition within an Australian context. This analysis is complemented by investigating the importance and benefits of a manufacturing transition within a ‘new’ production economy in section 1.2. The theoretical basis for study and the knowledge contributions to be made for advancing policy initiatives at micro and macro-economic levels is presented in section 1.3. Finally, comprising the body of the research study, an outline of the empirical chapters is provided in section 1.4. The three empirical chapters suggest that the all-encompassing definitions of ‘green’, ‘low carbon’ and ‘sustainable’ aim to achieve the same outcome – a new trajectory. The term ‘sustainable’ is used, as it captures the broadest definition of change for the purposes of a manufacturing transition. A critical objective of the research is not only to present the need for ‘greener’ production within the manufacturing sector, but also to advocate the importance for maintaining a viable and thriving (sustainable) manufacturing industry sector for Australia’s short, medium and long-term economic future.

## **1.1 A sustainable economy – a challenging transition**

As the race to create a lower carbon economy impacts advanced civilisations around the world, a growing body of research is exploring the effect that current economic ideologies have on such patterns of transition. According to these studies, conventional approaches to change are incremental and insufficient to address the climate change challenge and a fundamental transformation towards more sustainable modes of production and consumption (Markard, Raven and Truffer 2012). These literary sources are similarly limited in exploring the complexities facing manufacturers to make such a transition towards sustainable production. For manufacturing in general, Hulme (2009) suggests that climate change is seen as a problem waiting for a solution, whereas it should be viewed as an environmental, cultural and political phenomenon reshaping the way we think about society.

Such a societal view of sustainability is largely absent in the context of global politics of climate change and sustainability, which continues to focus on whether humans are responsible for a changing climate, and if so, what the most appropriate policy response is. Market driven and technological solutions tend to be the main focus. Diesendorf (2014) describes market driven responses as the sum of millions of economic decisions made by firms and consumers in unconstrained markets. As a result, the current economic system does not attach a value to the environment or price external environmental costs of products. Similarly, technological fixes tend to neglect the social and cultural context of the economic system and instead focus on improving efficiencies within existing infrastructure.

Consequently, traditional economic policy approaches alienate the environment and deny a progressive and socially just transformation from the current model (Kelsey 2014). Such a predicament is placed in context by Stern (2008), who estimates that in a ‘business as usual’ scenario, the current economic impact of climate change will be equivalent to losing at least 5.0 per cent of GDP each year.

This environmental positioning debate is reflected across key political and industry agendas in Australia. Potential policy changes that acknowledge the benefits of sustainable production to both business and society, are somehow challenged by how the transition discourse impacts upon existing neo-liberal policy ideology. The result has been to stifle any fundamental shift towards a systematic sustainable economy. Table 1.1 demonstrates the incremental development of climate and

sustainability policy between 1998 and 2015 and the associated implications for manufacturing and industry policy in Australia (Beeson and McDonald 2013).

Table 1.1: An overview of climate and manufacturing policy in Australia between 1998 and 2015

<b>Australian Political Leadership</b>	<b>Climate Change &amp; Sustainability Policy</b>	<b>Manufacturing &amp; Industry Policy</b>
<b>Howard-led Liberal/National Party Coalition Government March 1996 – November 2007</b>	<p>1998 - Australian Greenhouse Office established to reduce greenhouse gas emissions.</p> <p>2001 - Mandatory Renewable Energy Target scheme: 2% electricity sourced from renewable or specified waste-product energy sources.</p> <p>2002 - Australia launched climate strategy to meet Kyoto targets and adaptation needs.</p> <p>World Summit on Sustainable Development in Johannesburg, urging global action.</p> <p>2005 - International Energy Agency recommended an Emissions Trading Scheme (ETS) for Australia.</p> <p>2007 - Howard promised ETS if re-elected, National Climate Change Adaptation Research Facility announced.</p>	<p>1996 - Coalition Industry Policy Statement – government working in partnership with industry to overcome areas of market failure and future growth. Main investment focus on automotive sectors.</p> <p>1999-2000 - Policies to improve performance of Australian manufacturing: science and innovation systems established, financial assistance reduced, non-tariff barriers largely eliminated, research and development (R&amp;D) tax concessions implemented. Automotive and textile industries continue to dominate industry policy. Education and vocational training outdated.</p> <p>2000 - Mining resources boom, manufacturing shifts in priority for Australia.</p>
<b>Rudd-led Labor Party Government</b>	<p>2007 - Department of Climate Change and Water established.</p> <p>2008 - Garnaut Climate Change Report proposes Australia establish effective climate policies, including an ETS.</p>	<p>Over 200,000 manufacturing jobs disappear between 2007 and 2010.</p> <p>Clean energy finance package to assist heavy emitters and industry reduce emissions and assist manufacturing retool for climate change.</p>

<b>November 2007 – June 2010</b>	2009 - A new target to reduce emissions by 20% by 2020 on 2000 levels. Launch of clean energy initiative to support the development of low carbon energy. Fifteenth UN Framework Convention on Climate Change (UNFCCC) held in Copenhagen, Denmark.	
<b>Gillard-led Labor Party Government June 2010 – September 2013</b>	<p>2010 - Multi-Party Climate Change Committee created. Sixteenth UNFCCC COP held in Cancun, Mexico.</p> <p>2011 - Clean Energy Act 2011 provided framework for ETS starting with three-year fixed-price phase.</p> <p>2012 - UN Conference on Sustainable Development (Rio+20): urgent need for action on climate change highlighted.</p> <p>Australia created \$10 billion Clean Energy Finance Corporation (CEFC)<sup>2</sup> and climate Change Authority (CCA)<sup>3</sup>.</p>	Asia Pacific Economic Forum supports a list of environmental goods for tariff liberalisation.
<b>Abbott-led Liberal Party Government September 2013 – September 2015</b>	<p>2013 - Government repealed Clean Energy Act 2011, abolished Climate Commission<sup>4</sup>, ordered CEFC to cease investments.</p> <p>Direct Action Plan<sup>5</sup> introduced to replace ETS. Climate Council replaced Climate Commission funded by \$900,000 in private donations.</p>	<p>2013 – Manufacturing continues to contract, contributes 6.8% to GDP.</p> <p>2014 – Mining activity decreases and services sector expands, slowing down of growth in Asia, lower Australian dollar and free-trade agreements negotiated. Holden and Ford automotive companies announce factory closures and cessation of vehicle manufacturing in Australia.</p>

<sup>2</sup> Australian Government-owned Green Bank that was established to facilitate increased flows of finance into the clean energy sector.

<sup>3</sup> Provides independent expert advice on Australian Government climate change mitigation initiatives.

<sup>4</sup> An independent body established in 2011 by the Australia Government, to communicate ‘reliable and authoritative information’ about climate change in Australia. It was relaunched in 2013 as an independent non-profit organisation called the Climate Council and funded under new arrangements.

<sup>5</sup> The government will pay for projects that reduce Co<sup>2</sup> emissions such as energy efficiency projects, cleaning up power stations, reforestation and revegetation or improvement to soil erosion as opposed to a carbon tax policy scheme set by the previous government (Parliament of Australia 2015).

	<p>2014 - CCA reviews Australia's climate change progress and recommends a minimum reduction of 15% in greenhouse gas emissions from 2000 levels by 2020. Energy Green Paper released.</p> <p>2015 - Renewable Energy Target released.</p>	<p>Australian Industry Report released: Reduce regulatory burden, increase collaboration and commercialisation, improve engagement with global markets and supply chains and enhance management and workforce skills. Six industry growth centres announced: Food and Agribusiness, Mining-Equipment-Technology and Services, Oil and Gas and Energy Resources, Advanced Manufacturing and Medical Technology and Pharmaceuticals.</p> <p>Manufacturing sector and employment contracting by 1.2% annually (printing, machinery and equipment, non-metallic mineral products, wood and paper products), factory closures and redundancies. Demise of aluminium and automotive assembly in Australia. Industry 4.0 initiative – manufacturing automation, additive and digital manufacturing strengthens its focus. Housing construction boom.</p>
<p><b>Turnbull-led Liberal/National Party Coalition Government September 2015 - present</b></p>	<p>2015 - Department of the Environment and Energy is established. Australia ratifies Paris Climate Agreement. Government announces target of net zero emissions by 2100.</p>	<p>Australian Innovation System Report and Australian Government Industry Innovation Agenda released: Lower cost, business friendly environment, more skilled labour force, better economic infrastructure and industry policy that fosters innovation and entrepreneurship.</p> <p>2016 - Manufacturing in transition. Small-Medium Enterprise (SME) growth, niche high value, low volume manufacturing. Continuation of Free Trade Agreements and low taxes.</p>

Table 1.1 demonstrates that a shift to substantive climate policy action and subsequent engagement of key industry sectors, began in the mid-2000s following the formation of the Australian Greenhouse Office. Both the John Howard-led Liberal/National Party Coalition Government and the Kevin Rudd-led Labor Party opposition committed to some form of carbon pricing scheme in the lead up to the 2007 election, despite Howard remaining opposed to ratifying the Kyoto Protocol. This climate policy focused on investment in climate science, renewable energy technology, public education campaigns and business energy efficiency initiatives. However, there was limited scope to address the impacts of sustainability and climate change for polluting industries until Rudd came to office in 2007. The new government immediately ratified the Kyoto Protocol and established the Department of Climate Change and Water.

Under the leadership of Rudd, the Garnaut Climate Change Review (Garnaut 2011) was commissioned to conduct an independent study of the impacts of climate change on the Australian economy. The Review's report, released on 30<sup>th</sup> September 2008, recommended policy frameworks for improving Australia's sustainable economic position. In November 2010, the Australian government, under Gillard, commissioned Professor Ross Garnaut to provide an update to the 2008 Climate Change Review. The update highlighted Australia's vulnerability to climate change and recommended a range of policies for industry including an Emissions Trading Scheme and a 'retooling for climate change' program. Many of these policies were adopted as part of the Clean Energy Package announced in 2011, along with establishing Australia's first carbon tax, the Australian Carbon Trust<sup>6</sup>, and a 20.0 per cent renewable energy target.

This legislation was identified by Beeson and McDonald (2013) as the first significant policy breakthrough in Australia's climate policy history, and provided some certainty for the clean technology sector to advance renewable investments and low carbon niche product development, as well as helping to shape a global climate change solution (Department of the Environment and Energy (2012). The carbon tax and its associated possibility of emissions trading with European markets was conceived as the core substantive mitigation strategy for achieving emission reductions, along with investment in renewable energy technology. Markey, Wright and O'Brien (2016) highlight that the

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<sup>6</sup> Australian Carbon Trust's goal is to accelerate the move to a low carbon economy.

anticipation and implementation of a price on carbon incentivised many manufacturing firms to reduce emissions and introduce energy efficient practices through technological and organisational innovation initiatives.

However, the Coalition Government elected in September 2013 abolished the carbon tax and associated legislation. As a result, many of the clean energy initiatives were repealed in favour of a direct action plan to address climate change and sustainability. This plan involved initiatives to pay for ventures that directly contributed towards reducing Co<sup>2</sup> emissions. These included energy efficiency technology projects, reforestation and revegetation programs to improve land degradation and capture carbon emitted, as opposed to a carbon tax policy scheme. During this time, the government recognised that manufacturing was in decline and as such, plant and factory closures were imminent, ultimately reducing carbon pollution.

## **1.2. A ‘new’ production economy**

The beginning of this chapter has illustrated that over the last few decades there has been a significant shift in the manufacturing sector. Many factories have either transferred production to lower cost locations or closed altogether. Much traditionally mass produced manufacturing or routine activities have disappeared or been replaced with more complex and advanced manufacturing techniques raising new and increasingly complex challenges (Van Winden et al. 2010). As a result, there has been a significant decline in manufacturing employment and output, and an increase in service sector employment and productivity.

Historically, manufacturing has made a significant contribution to Australia’s economic development and GDP, mainly in the form of producing consumer goods for the domestic market (Milne 2010).

During the 1940s, government economic policy stimulated large scale investments in national production, enabling Australia’s small manufacturing sector to rapidly grow and by the 1950s, manufacturing accounted for 29.0 per cent of GDP. However, over the next several decades, Australia experienced symptoms of unbalanced growth owing to the exploitation of its minerals and land wealth, and manufacturing began its well-documented decline. Attempts to revive the industry by introducing economic stimulus policies, lower income tax rates, higher wages and deregulation in the 1980s, only contributed further to this decline by promoting short-term entitlement rather than a long term



economic and social development agenda. Flow on effects of these initiatives included plant closures and the dislocation of workers and families, particularly in industrial regions where the challenges of economies of scale were recognised. Between 1975 and 2013, the manufacturing sector's contribution to GDP fell from 15.0 to 6.5 per cent. Australian politicians and scholarly experts began to question if Australia should manufacture at all (Gibson, Carr and Warren 2012). The debate included consideration of whether the decline of manufacturing was a natural process and if the market should be left to do its job? Additional questions were raised about if a diminishing manufacturing sector had wider implications that could be addressed by specific industry or regional policy?

In favour of the latter perspective for taking action to address a declining manufacturing sector, Stanford (2016, p.4) argues that it would be difficult to imagine an economy without manufacturing, as 'human beings have material needs and wants that can only be met through the production and transformation of material goods'. Stanford (2016) insists that people cannot eat information or knowledge, wear it, or live in it, but as digital technology and skills and education improve, all work performed will involve more and faster flows of data absorption, changing the face of manufacturing and types of policy initiatives to assist in its development. However, this does not imply that the work associated with transforming materials into more useful end products disappears — only that it is done differently (Stanford 2016).

In response to these arguments, manufacturing has re-emerged on the domestic political agenda with support from the Australian government for stimulating innovation and advanced technological change. Following a series of recommendations presented by the Australian Manufacturing Taskforce in 2011, the government initiated the formation of six industry growth centres to generate innovative, niche opportunities that could be exported to the world. One such centre, the Advanced Manufacturing Growth Centre (2016) is aiming to rebuild Australian manufacturing capability beyond a focus on end-production goals. A national manufacturing competitiveness plan has been developed to steer cost reductions of production inputs and improve efficiency through advanced manufacturing techniques. From the perspective of the Advanced Manufacturing Growth Centre, the manufacturing firm of tomorrow will focus on technological innovation, customisation and higher value product markets, and be part of global value chains. However, as this thesis will demonstrate, traditional manufacturing

firms and the regions that they are located in, are at diverse stages of social, technological and organisational change, and hence each respond differently to national and state policy agendas.

This thesis provides a detailed insight into the transition attributes that are present in divergent traditional manufacturing firms and regions. It is hoped this research will contribute to building a tailored policy framework that facilitates the enabling conditions and an operating environment to address gaps in current industry and regional policy and steer the manufacturing sector towards a sustainable future.

### **1.3. A sustainable manufacturing transition**

Against the background in sections 1.1 and 1.2 and emerging from the intersection of evolutionary economics, institutional theory and science and technology studies (Markard, Raven and Truffer 2012), sustainable transition research has begun exploring the socio-technical system attributes of established industry sectors. This field of inquiry aims to understand the network of actors (individuals, firms and other organisations) and institutions (societal and technological norms, regulations and standards) as well as the material agency and knowledge (Geels 2004) that inhibit niche-innovation and prolong incremental change. The systems concept illustrates the diversity of elements that are interrelated and dependent on each other and hence have implications for the transformation of the system (Markard, Raven and Truffer 2012). Thus, for this research study, a sustainable transition is achieved when a set of processes trigger a fundamental shift in the manufacturing socio-technical regime, leading to sustainable modes of production and consumption.

At the same time, Markard, Raven and Truffer (2012) point out such an analysis, that includes aspects of economic geography, management studies and political science, remains disconnected from the sustainable transitions literature. In response, this thesis enriches the theoretical basis, within the transition community, by weaving together diverse threads of reasoning from different disciplines to develop new perspectives in transition research (Lagendijk 2006). One line of thought not yet examined within the field, is the influence particular actors and institutions have on the transition process. The political manufacturing regime tends to focus on technological solutions for change, rather than on a broader understanding of user practices and cultural institutions. For example, the Advanced Manufacturing Growth Centre, whilst addressing industry competitiveness, supports the

development of a technologically advanced manufacturing sector, which specialises in niche products and processes where Australian expertise demonstrates a point of difference (Goennemann 2015). Technological features however, address only part of the solution to a restructuring of the manufacturing sector (Green and Roos 2012). Minimal consideration has been given to how advanced manufacturing systems can, at the same time, reconfigure behaviours, practices and cultural mindsets for change and contribute to forming a lower carbon and sustainable economy.

This thesis identifies and introduces a range of different actors and institutions into the arena of sustainable transition research, which presents significant opportunity for distinguishing alternative pathways, a reconfiguration of the manufacturing sector and a more diversified policy approach towards long-term change. The study provides a holistic analysis of relevant socio-technical characteristics within the sector not limited to individual firm responses and technological change. Consideration is given to analysing external and internal spatial relationships, collaborations and regional knowledge networks within the manufacturing domain (Coenen, Moodysson and Martin 2014). Additionally, the literature on old industrial regions (Trippel and Otto 2014; Todtling and Trippel 2009) provides an evolutionary change perspective for transition research. In particular, these contributions consider place-specific challenges related to lock-in of mature regional industries, but also discuss the creation of pathways that have the potential to unlock regions and industries through socio-technical renewal. Findings presented within this thesis will show that regional actors are often aware of the bottlenecks that prevent a ‘breaking out of the mould’, but struggle to find practical solutions to do so. But, empirical studies are needed to facilitate a more informed, integrated and practical response that enrich tailored policy frameworks and industry engagement.

Against this literary background, sustainable innovation policy for transformative change needs to focus much less on the features of products, processes, firms and research and development, which tend to align supporting each other, and form part of a regime. Such a path will not suffice to adapt an already complex manufacturing sector struggling to manage the impacts of environmental degradation, resource-intensive practices and fossil fuel based examples of mass production (Schot 2016). Instead, sustainable innovation policy requires greater emphasis on addressing systems-wide transformation of the socio-technical configuration made up of skills, infrastructures, industry assemblies, user

preferences and institutional factors (Schot and Steinmueller 2016). Systems transformation requires a broad change process, which gives the development of traditional systems new direction aimed at addressing social, economic and environmental challenges (Smith, Voß and Grin 2010; Markard, Raven and Truffer 2012). Such strategies highlight the role of sustainability and innovative production techniques in transitioning the manufacturer, creating spaces for developing market niches or alternative processes, and provide a vehicle for actors driving transitions to make change that may otherwise be inhibited.

Positioning this research within the field of systems innovation, reinforces the need for radical change in generating a new manufacturing arrangement that is embedded within the broader economy (Rip and Kemp 1998; Smith, Voß and Grin 2010; Schot and Steinmueller 2016). In this instance, manufacturing involves employing new technologies as well as the remaking and reuse of old technology for an advanced and sustainable future, but it also involves non-technological attributes and multiple actors across the industry and society who play a critical role in the creation of new systems (Schot 2016). This thesis is not suggesting that there is one single pathway for a transition to sustainability. Rather, the process of systems innovation involves negotiating many alternative pathways, each with the potential for setting a trajectory for system change (Stirling 2015) and a willingness to revisit existing measures to address societal challenges. A socio-technical transitions approach makes room for developing a compatible evolutionary framework to understand the wider context in which such processes of transformative change play out.

#### **1.4. Overview of the thesis chapters**

This thesis consists of seven chapters; of these, four core chapters (3-6) have been written in a format for submission to peer reviewed journals for publication, and Chapter 3 has already been published. The overall structure of the thesis is illustrated in Figure 1.1. Chapter 1 has explained the broader background to transition in manufacturing in socio-economic terms, as well as the environmental impact that necessitate moving to more sustainable manufacturing. The overall approach and expected contributions of the proposed combined analyses are explained and summarised in the main research questions. This review of manufacturing change in Australia, knowledge gaps and investigation strategies forms the basis on which to discuss research design and methodology in detail in the next

chapter. Chapter 2 is a detailed discussion of the study methodology and research design strategy employed, including the ethical implications of the research, positioning of the researcher, phases of data gathering, reflection on the methods chosen and how empirical findings were analysed. Subsequent empirical chapters necessarily contain summaries of methods; however, this chapter provides the methodological basis for all the sub-studies, including the investigations in Chapter 3 on identifying the attributes of a sustainable transition and developing a conceptual framework.

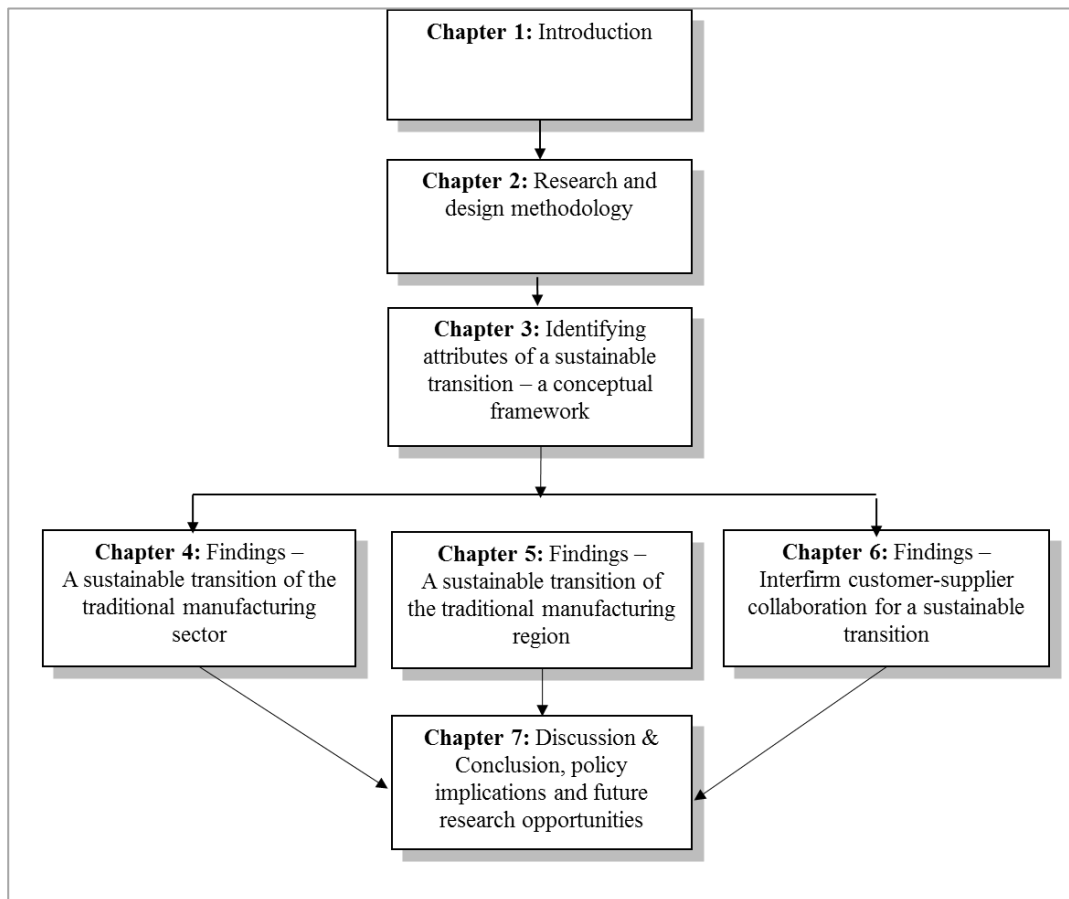


Figure 1.1: Overview of thesis chapters

As this study was designed as a thesis by publication, a number of core chapters are written as stand-alone research articles for submission to nominated peer-reviewed journals; however, to minimise repetition and improve the flow of this thesis document, the abstracts of Chapters (3-6) have been placed in Appendices (G – J) and individual reference sections combined in a single list at the end. Linking statements at the beginning and/or end of each chapter have also been added.

The first phase of inquiry in Chapter 3, undertook a meta-review of sustainable transitions research across a range of case studies, conceptual frameworks and models. It explored gaps in the transition literature and highlighted an absence of evidence drawing together approaches to identify elements and attributes of long-lasting transitions in traditional manufacturing sectors. The review culminates in proposing an interdisciplinary conceptual framework. Rather than considering the elements of one conceptual framework in isolation, the Attributes of a Sustainable Transition model draws together four existing conceptual approaches including ‘Advanced Manufacturing’, ‘Sustainable Transitions’, ‘Regions are Spatial’ and ‘Transition Regions’. This innovative approach contributes towards the development of a new perspective to investigate the theoretical and practical steps towards generating a transition of the manufacturing system to include human-centred and spatially oriented thinking as well as technological considerations, for understanding evolutionary industry change.

Building on the previous chapter, Chapter 4 is the first of three empirical chapters, testing the first two parts of the Attributes of a Sustainable Transition theoretical framework – ‘Advanced Manufacturing’ and ‘Sustainable Transitions’ to ask, *what are the attributes of a sustainable transition for the traditional manufacturing firm and industry sector in Australia?* An advanced manufacturing approach encompasses the whole chain of operation from research and development to end of life management, and a sustainable transition approach requires the analysis of new environmental problems at the social as well as technical level, considering the existing system and societal domain in which an organisation operates. This chapter explores the sustainable transition attributes of 24 individual manufacturing firms, and demonstrates how firm level analyses can be aggregated, enabling an understanding of systematic change across the industry sector.

Chapter 5 goes on to consider the second two parts of the conceptual framework, ‘Regions are Spatial’ and ‘Transition Regions’ to ask, *what are the attributes of a sustainable transition for the traditional manufacturing Australian region?* Regions have been missing from most traditional industry renewal studies, but are important spaces from the transition viewpoint. Focusing on regions permits investigation of the spatial and relational context for a sustainable trajectory, validated by a transition region approach which explores the spatial considerations in transitioning to an advanced manufacturing model. This theoretical framework enables an understanding of the regional path-

dependent, related variety and proximity features<sup>7</sup> of individual firms and actors for regenerating the traditional manufacturing sector.

Whilst Chapters 4 and 5 focus on the supply side of transition research, Chapter 6 unites the elements of the Attributes of a Sustainable Transition theoretical framework to explore the demand side and asks, *what is the role of the interfirm customer (original equipment manufacturer) in influencing a sustainable transition of the traditional manufacturer (supplier) in Australia?* Specifically, it investigates the theoretical contribution of ‘Technological Innovation Systems’ synthesised with ‘Sustainable Collaboration’ studies, to explore the relational characteristics of four interfirm customer-supplier manufacturing case studies.

To conclude, Chapter 7 emphasises the relevance of combining approaches to promote future sustainability opportunities. Combining theoretical approaches of advanced and innovative manufacturing with sustainability and transition studies assists in guiding a systematic transition of Australia’s manufacturing sector. This theoretical hypothesis is tested and empirical findings are summarised to display how this thesis has addressed gaps within the academic research agenda. This discussion is complemented by bringing together case study material that simultaneously offers policy makers and practitioners new knowledge into the challenges, opportunities and attributes of a sustainable transition for the traditional manufacturing sector in regions of Australia.

In addition to abstracts of papers and conference presentations included in the appendices, essential verifying administrative documents are included for reference if required.

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<sup>7</sup> Transition Region terms for – path-dependent (reliant on same direction), related-variety (sector of similar skills, capability, technology and knowledge) and proximity (physical, relational and cognitive distance).

## **Chapter 2 - Methodology**

One aim of this thesis was to design a research process that facilitates an improved comprehension of the challenges and opportunities facing traditional manufacturing firms in transition. This chapter details the research methodology for collecting empirical data and ensuring rigour in the design process. It considers ethical implications of the research, how the researcher was positioned within the study, phases of research design, including selection of participants and data gathering strategies, reflection on the methods chosen and the ways in which empirical information was analysed.

### **2.1 Ethical considerations**

To obtain formal ethics approval, the researcher was required to submit an application to the Faculty of Business and Economics Human Research Ethics Sub-Committee, Macquarie University. The application involved justifying the purpose of the study, who would be involved and what research participants were being asked to do. The process also required the researcher to define the aims, duration and financial requirements of the research. Each participant received a Participant Information Sheet and Consent Form (Appendix A) to address key ethical considerations including privacy, confidentiality and informed consent. Approval to proceed was received by the Ethics Committee on 30<sup>th</sup> March 2015, Reference Number: 5201500130 (Appendix B).

In designing the research study, it was essential to consider firm and regional stakeholder availability and time to participate. Therefore, to select and recruit participants, coordinate semi-structured interviews and focus groups and build a level of trust, making contact with research participants was facilitated by an industry representative in each region. One of the key day-to-day roles of these intermediary<sup>8</sup> actors is to enable connections and identify which partnerships could contribute to building manufacturing knowledge and capability. These individuals were well known to the manufacturing firms in each region.

### **2.2 Researcher Positionality**

Positionality is described by Dowling (2009, p.836) as a ‘process of constant self-conscious scrutiny of the self as a researcher, and of the research process’. Thus, researchers with diverse biographies can be

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<sup>8</sup> An actor/agency/organisation who acts as a link or facilitator for regional development.



positioned differently. Following a project management role with Regional Development Australia Illawarra, the researcher brought a particular ideology to the study and was cognisant of the drivers and barriers impacting change in regional manufacturing firms. The investigation commenced with certain expectations, beliefs and interest in how path-dependent industrial regions manage the shift towards renewal. Figure 2.1 illustrates the changing nature of the researcher's positionality throughout the fieldwork phases. For example, initially most manufacturing firm participants positioned the researcher as a student collecting data for a PhD thesis. However, during the course of the fieldwork, participants became interested in gaining knowledge from the research findings and an insight into the change process; this repositioned the researcher as a quasi-consultant. Having previously built credibility with local industry, the researcher was known to Wollongong participants and consequently, some participants saw the study as an opportunity to advocate for policy change in the transition of manufacturing. In Newcastle and Geelong, the researcher was positioned as a knowledge broker facilitating exchange between the three manufacturing city regions. The researcher was encouraged by city region representatives to present the results of the research findings upon conclusion of the study. Similarly, during the customer semi-structured interviews, respondents saw the study as an opportunity for providing and brokering supply chain connections from within the three city regions and beyond.

### **2.3 Phases of Research Design**

Data was gathered over five phases between April and October 2015. First, three city regions were selected. Second, 24 manufacturing firms from each city region were identified and recruited. Third, the general manager from each manufacturing firm was interviewed. Fourth, three focus groups including government and non-government stakeholders were facilitated, one in each of the city regions. Fifth, nine customers (original equipment manufacturers - OEMs<sup>9</sup>) were chosen and their relevant business managers interviewed.

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<sup>9</sup> The maker of a system that includes other companies' subsystems, an end-product producer. For example, when referring to automotive parts, OEM refers to the manufacturer of the original equipment, that is, the parts assembled and installed during the construction of a new vehicle, for example.

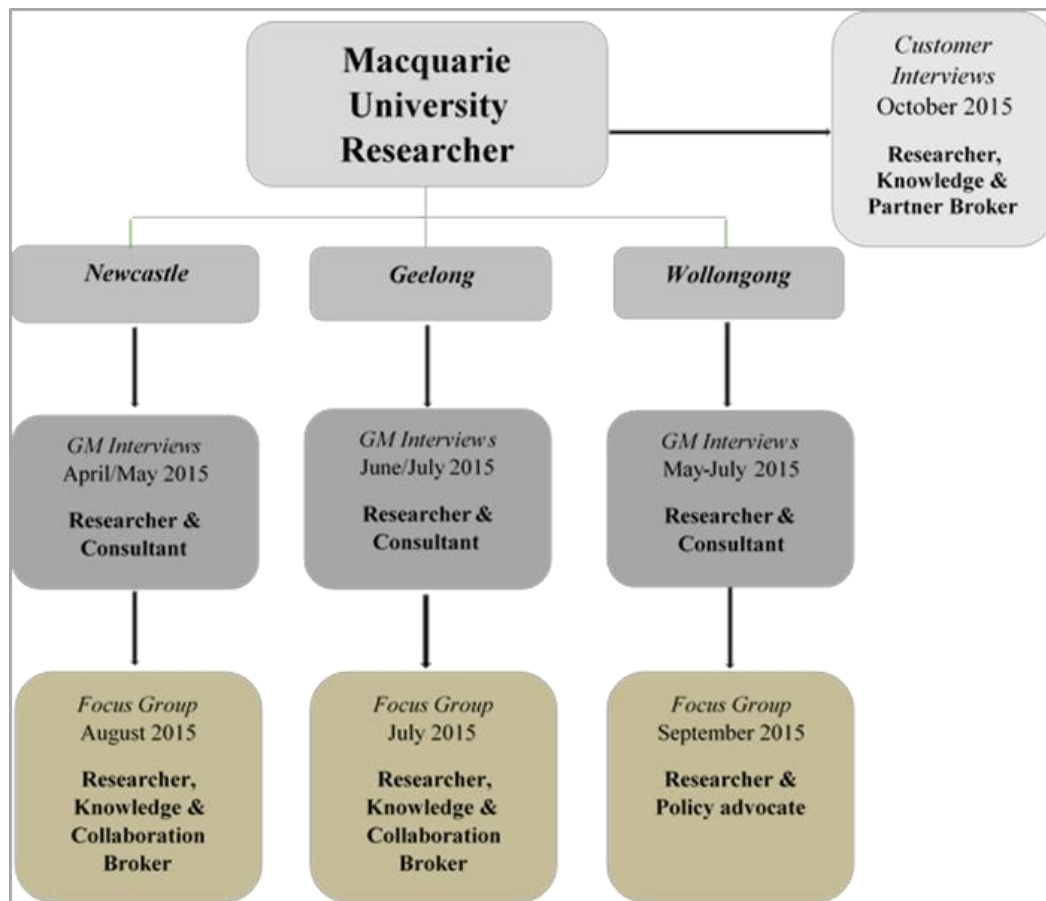


Figure 2.1: Changing nature of researcher's positionality

Table 2.1 provides an overview of the research design methods and data gathering phases employed in each chapter. A case study and qualitative mixed-method fieldwork approach was deployed to collect empirical data. Lieber and Weisner (2010) note that the multiple qualitative methods approach allows the researcher to tackle a given research question from a range of angles, making use where appropriate of more than one type of investigative perspective.

### 2.3.1 Phase One – City region selection

A criterion sampling strategy (Lockwood et al. 2007) was employed to select three Australian city regions for study. Selection criteria included: a region's proximity to a capital city, east coast location, traditional manufacturing origin (construction, chemicals, heavy engineering, machining and metals), experience of structural change and involvement or interest in advanced and sustainable manufacturing. Based on these characteristics, the city regions of Newcastle, Geelong and Wollongong were chosen.

Table 2.1: Research design methods employed in each chapter

Chapter	Analysis	Data
3	Meta-literature review and development of theoretical framework	Peer-reviewed article <sup>10</sup> combining the concepts of advanced manufacturing, sustainable transitions, regions are spatial and transition regions to build the theoretical framework 'Attributes of a Sustainable Transition'
4	Qualitative discourse and cross-case study analysis	Perspectives of transition attributes by manufacturing firm general managers (N=24). Data collected through semi-structured interview process during April – July 2015 in Geelong, Newcastle and Wollongong
5	Qualitative discourse analysis, case study comparison	Perspectives of city-region transition context by manufacturing firm general managers (N=24). Three focus groups including government, non-government and employer group representatives conducted during August to September 2015 (N=20) in Geelong, Newcastle and Wollongong
6	Qualitative discourse analysis, case study comparison	Perspectives of transition attributes by customer OEMs (N=9). Data collected through semi-structured interview process during October 2015 in Sydney and Melbourne

Table 2.2 provides a comparative summary of the socio-economic characteristics of each city region, including a brief description of its social composition, economic make up, intermediary actors and organisations present, knowledge assets, quality of life and transport accessibility. Table 2.2 indicates that a stronger economy exists in Newcastle and Geelong compared to Wollongong, but there is slower population growth in Newcastle and Wollongong. Wollongong has strong ties to the Sydney labour market which draws skills and labour from the region. Geelong and Wollongong both display a higher number of low-skilled workers and fewer professionals than Newcastle, which also aligns with examples of firm qualification and lower skill levels illustrated in Table 2.3. Geelong and Newcastle host advanced medical and clean technology research capability led by local university institutions. High quality road, rail and port infrastructure facilitate access to each city region, with the Port of Newcastle being the largest in Australia. Geelong and Newcastle both service domestic capital city flights from regionally located airports.

<sup>10</sup> Chapter 3 is a published article. Skellern, K, Markey, R and Thornthwaite, L 2017, 'Identifying attributes of sustainable transitions for traditional regional manufacturing industry sectors - a conceptual framework', *Journal of Cleaner Production*, vol. 140, pp. 1782-1793.

Table 2.2: Summary of city region socio-economic characteristics

	City Region Geelong (Barwon South West), Victoria, ( <a href="#">Regional Development Victoria 2016</a> )	City Region Wollongong (Illawarra), New South Wales (NSW) ( <a href="#">IRIS Research 2016</a> ; <a href="#">NSW Trade &amp; Investment 2015a</a> )	City Region Newcastle (Hunter), NSW ( <a href="#">NSW Trade &amp; Investment 2015b</a> )
<b>Social Base</b>	Approx. 410,000 (Geelong local government area (LGA) 220,000 population) = 1.26% growth, land area 1,245sqkm, Victoria's largest regional centre, 75kms from Melbourne.	Approx. 413,000 (Wollongong LGA 200,000) population = 0.90% growth, land area 714sqkm, 80kms from Sydney.	Approx. 541,950 (Newcastle LGA 161,225) population = 0.82% growth, land area 187sqkm, 160kms from Sydney.
<b>Economic Base</b>	Manufacturing history in wool, gold, automotive, distilling, woollen mills, cement and fertilisers. Growth in defence, agriculture, advanced manufacturing, social services, health, finance, retail and tourism. 81,000 in workforce. Ford Motor Company major employer until 2017. Structural adjustment package due to downsizing of automotive industries. Geelong's Gross Regional Product (GRP) = \$11billion, 80% of G21 Region's GRP (\$14billion), 3% of Victoria's Gross State Product (GSP) (\$361billion) and 0.7% of Australia's GRP (\$1.6trillion).	History of heavy manufacturing (steel & coal). BlueScope Steel large employer. Growth in IT, business & finance, education & research, logistics, defence (HMAS Albatross), advanced manufacturing, tourism, health & aged care. 89,050 in workforce. Structural adjustment package due to downsizing of local steel industry. Lease of Port generated \$ regional investment. Wollongong's GRP = \$12billion, 61% of Illawarra's GRP (\$19billion), 2% of NSW's (GSP) \$513billion and 0.74 % of Australia's GRP (\$1.6trillion).	No longer a 'steel city' (BHP closed 1999) but mining and construction industry still strong. Growth in defence (Royal Australian Air Force - RAAF Williamstown Joint Strike Fighter (JSF) project), health care, social assistance, scientific & technical, financial & insurance, advanced manufacturing, tourism, mining, wine and equine industries. Structural adjustment package due to closure of steelworks. Lease of Port generated \$ regional investment. Newcastle's GRP = \$15billion, 34% of Hunter Region's GRP (\$43billion), 3% of NSW's (GSP) of \$513billion and 0.92 % of Australia's GRP of \$1.6trillion.
<b>Intermediary organisations (highlighted by respondents)</b>	Geelong Manufacturing Council (GMC), City of Greater Geelong, Clean Tech Innovation Geelong, Government (Environment Protection Agency (EPA), Office of Environment & Heritage (OEH), Trade & Investment (T&I)), Enterprise Geelong, Australian industry (Ai) Group, unions.	Government (T&I, OEI, AusIndustry, Regional Development Illawarra (RDAI)), Ai Group, Business Chamber, LGA, TAFE, Southern Manufacturing Innovation Group (SMIG), i3net, unions.	Government (OEI, T&I, Regional Development Hunter (RDAH), Ai Group, Business Chamber, Hunternet, LGA, Hunter Manufacturing Innovation Cluster, unions.
<b>Knowledge Base</b>	Deakin University, Gordon Institute of TAFE, Commonwealth Scientific, Industrial Research Organisation (CSIRO) - Animal Health & Textiles/Fibre Technology. Limited no. population with degree/diploma, Larger no. population with vocational qualifications. Less professional/managers, More trade/tech & community service workforce, unemployment 5%.	University of Wollongong (UOW), Illawarra TAFE, More unskilled & semi-skilled employment, Less professional/managers (but increasing), 56.8 post-school qualifications, unemployment 6.9%.	University of Newcastle (UON), Newcastle Institute Energy & Resources (NIER), Australian Solar Thermal Research Centre (CSIRO), Hunter Medical Research Institute (HRMI), More skilled workforce, 54.6% tertiary, unemployment 5.4%.
<b>Quality of Life</b>	Mix of coastal, country & suburban, high residential growth, waterfront precinct, yacht club, museums, Geelong Grammar, Great Ocean Road tourism.	Mix of coastal, escarpment, national parks, new residential growth, attractive house prices (but increasing), beach amenities and lifestyle, schools, hospitals, 12% workforce commute to Sydney.	Mix of coastal, wine and equine region, residential and industrial growth, tourism, museums, art & culture lifestyle.
<b>Accessibility</b>	Road, rail, Avalon airport, Geelong Port (\$6 billion trade).	Road, rail, one hour from Sydney airport, Port Kembla (\$418 million trade).	Road, rail, Newcastle airport, Newcastle Port (Australia's largest port \$19 billion trade).

### **2.3.2 Phase Two – Identifying and recruiting manufacturing firms**

Phase two initially involved identifying and recruiting a minimum of five traditional manufacturing firms in each city region (this number of firms was chosen to provide a benchmark for consistent recruitment numbers in each region for data gathering purposes). To achieve this, a meeting was held with the relevant city region industry representative to target potential organisations. Such a recruitment method may have biased the research sample by allowing each regional representative to provide a preferred selection of firms. However, by applying the criterion sampling strategy, firms were equally identified. Importantly, for the data gathering process, each regional representative ensured that the researcher was aware of any existing pressures on manufacturing firms, in providing time or resources for the study as well as other relevant insights. It was important to build upon this established relationship with the industry representative to overcome any challenges and ensure a rigorous recruitment process, at the same time as remaining reflexive and open.

Letters of invitation to participate in the study were distributed to the general manager of each selected firm, outlining the scope of the study and level of individual involvement required. A total of 24 firms agreed to participate in the interviews. Nine firms in Geelong, eight firms in Newcastle and seven firms in Wollongong were recruited. Table 2.3 presents some general characteristics of each firm. Table 2.4 specifically highlights the general manager interviewee characteristics, including employment location, age range, qualifications and length of existing employment. It is important to note that each firm provided an overview of their individual sustainability position, but these views were not representative of all manufacturing firms in each city region. As Robinson (1998, p.409) emphasises, in qualitative research 'the sample is not intended to be representative, since the emphasis is usually on the meanings in specific contexts'. Pseudonym codes identified as Person and Firm A, B and so on, have been used to protect the identities of participants.

Tables 2.3 and 2.4 also outline the similarities, differences, operational context of the firm and interviewees. For example, the traditional manufacturing industries represented included two firms (8.0 per cent) in chemical/pharmaceutical, two (8.0 per cent) in textiles, three (12.5 per cent) in bespoke engineering, four (17.0 per cent) in building and construction, four (17.0 per cent) in steel fabrication and mining and nine (37.5 per cent) in machining/metals/heavy engineering. Sixteen (67.0 per cent)

general managers have been employed within the firm for over ten years, 14 (58.0 per cent) are aged fifty years or more and 22 (92.0 per cent) are male with a tertiary qualification in engineering, business or marketing. Person R and U from Geelong were the only female participants interviewed. Firms established prior to the year 2000 equalled 20 (83.0 per cent). Similarly, 20 (83.0 per cent) are classified as small to medium enterprises (SMEs) (Organisation for Economic Co-operation and Development 2014), with 10 (42.0 per cent) nominating an average annual turnover of less than \$12.7 million, 10 (42.0 per cent) under \$74 million and 4 (16.0 per cent) over \$74 million. Three of four (75.0 per cent) firms employed a workforce with a low-medium skill set, half the firms (50.0 per cent) were part of a multi-national corporation, and just over half (58.0 per cent) operated in domestic markets only, with the remainder participating in global markets to varying degrees.

### **2.3.2. Phase Three – General Manager semi-structured interview**

A one-on-one semi-structured interview of one to two hours with the general manager of each manufacturing firm was conducted. Questions and themes, included in Appendix C, were designed to identify the following elements of business operations:

- attributes, challenges and opportunities of current manufacturing products and processes,
- business development strategies,
- existing supply and demand channels,
- existing and potential collaborations,
- barriers to change,
- existing sustainability capabilities and skills, and
- current advanced manufacturing, sustainable transition strategies and other key attributes.

Table 2.3: General characteristics of each manufacturing firm

Firm	Region	Firm est.	Aus. Staff	Quals/Skill sets of employees	Av. \$ p.a	Company Structure	Core business	Market locations
A	Newcastle	2005	150	Materials engineering	50 - 100m	Single Entity	Composite material specialists (industrial, civil, engineering)	Australia, South-East (SE) Asia,
B	Newcastle	1987	24	Low skill levels across organisation	5 - 10 m	Group	Commercial catering equipment manufacturers	40% Australian capital cities and rest is regional
C	Newcastle	1980	54	Fitter, machinists, electricians, welders, engineers	10 - 50m	Group	Manufacture of refuelling systems and security monitoring	Australia, Americas, Africa, Asia
D	Newcastle	1971	35	Basic fitting/machining trade cert 3 or 4	N/A	Group	Subtractive manufacturing and machining	Mainly North America, small in Australia
E	Newcastle	2000	180	Low skills but upskilling automation/robotics	\$200m	Group	Underground mining and some civil	Asia Pacific
F	Newcastle	1886	650	90% High School Certificate (HSC), trades and apprentices, 10% degree	\$100m+	Group	Engineering and manufacturing	95% Australia
G	Newcastle	1968	700	Electricians, fabricators, fitters, electrical engineers	50 - 100m	Group	Electrical engineering and manufacturing mainly in mining	Eastern & Western Australia + global
H	Newcastle	2000	34	Mechatronic and electronic engineers	5 - 10m	Separate companies	Sales/supply subsea equipment & services, design/repair of electrical/mechanical equipment in advanced defence systems	Australia
I	Wollongong	2000	75	Contract & construction for commercial	10 - 50m	Single Entity	Commercial and residential construction in high end buildings	New South Wales (NSW), Australia
J	Wollongong	1977	62	Low skilled	10 - 50m	Single Entity	Chemical manufacturing	Sydney 85%, export 15% SE Asia + other national
K	Wollongong	2002	50	50% HSC 10% Degree	1 - 5m	Single Entity	Manufacturing frames and trusses	NSW
L	Wollongong	1975	67	Fitters, turners, boiler makers, welders, riggers, carpentry, concreting	10 - 50m	Group	Steel fabrication, civil construction, design and engineering	NSW and SE Asia
M	Wollongong	1915	90	Low skills, HSC	10 - 50m	Group	Manufacturing hot water storage tanks	Australia
N	Wollongong	1915	3500	Chemical engineers, materials engineers, specialists	\$8 billion	ASX	Flat steel producer/supplier of steel products and solutions to the global building industry	Australia, New Zealand and US
O	Wollongong	1976	45	Semi-skilled	5 - 10m	Single Entity	Bespoke manufacturing	Mainly Australia
P	Geelong	1966	700	Semi-skilled	200m+	Group	Manufacturing carpet and sales and marketing floor tiles	Australia, Asia, North America
Q	Geelong	1945	65	Low skills	10 - 50m	Group	Manufacture of ammunition, firearms and accessories	Australia, Asia, Europe & US
R	Geelong	1970	15	Engineers - automation, systems control	1 - 5m	Single Entity	Specialists in lean, agile & data driven manufacturing	Victoria, Australia
S	Geelong	1965	70	Textile mechanics and low skilled	10 - 50m	Group	Paper industries machinery manufacturer	Asia
T	Geelong	1986	30	Low skills	1 - 5m	Separate companies	Manufacture shower screens, shower bases and baths	Australia
U	Geelong	2003	10	Low skills	1 - 5m	Single Entity	Manufacture secondary glazing and draught proofing	Victoria
V	Geelong	2005	30	Marketing, sales	\$30m	Single Entity	Manufacturing recycled packaging & organics composting machines	Australia
W	Geelong	1974	150	Engineering, design, low skilled	\$12m		Heat exchanger manufacturing	Global and Australia
X	Geelong	1995	20	Mechanical, electrical engineers, draftsmen, boiler makers, fitters,	\$5m	Single Entity	Engineer, design, draw and make engineering solutions	Australia

Table 2.4: Summary of General Manager interviewee attributes

Person	Region	Age	Role	Qualifications & Skills	Length of Employment
A	Newcastle	51-55	Director Marketing & Sales/Shareholder	Bachelor Economics	5 to 6 years
B	Newcastle	25-30	General Manager	None	3 to 4 years
C	Newcastle	55+	General Manager	Bachelor Business	16 years
D	Newcastle	46-50	General Manager	Advanced Diploma	20+ years
E	Newcastle	40-45	Regional Chief Executive Officer	Bachelor Engineering and Business	19 years
F	Newcastle	51-55	Chairman and Managing Director	Bachelor Engineerig	22 years
G	Newcastle	51-55	General Manager	Bachelor Electrical Engineering, Masters Business Adminstration (MBA)	31/2 years
H	Newcastle	51-55	Co-Founder	Bachelor Engineering, MBA	17 years
I	Wollongong	35-40	Director	Bachelor Building and Construction	15 years
J	Wollongong	46-50	Managing Director	Bachelor Science, Masters Management	20+ years
K	Wollongong	41-45	Managing Director	Bachelor Building, Associate Diploma	13 years
L	Wollongong	31-35	Project Manager	Bachelor Commerce	41/2 years
M	Wollongong	55+	Operations Manager	Associate Diploma Mechanical Engineering/Bachelor Business	6 years
N	Wollongong	46-50	Manager	Associate Diploma Materials Science	20+ years
O	Wollongong	41-45	Managing Director	Trade Certificate Fitting and Machining	20+ years
P	Geelong	51-55	Group Operations Director	Bachelor Engineering/Diploma Business Management	11 years
Q	Geelong	55+	General Manager	Bachelor Commerce	9 years
R	Geelong	55+	Executive General Manager	Trained Nurse	20+ years
S	Geelong	41-45	General Manager	Qualified accountant	5 years
T	Geelong	55+	Managing Director	Civil engineer	39 years
U	Geelong	35-40	Managing Director	Certificate 4 Building Construction and Commerce	12 years
V	Geelong	50-55	Managing Director & Principal	Marketing skills	20+ years
W	Geelong	55+	General Manager	Mechanical engineering skills	51/2 years
X	Geelong	55+	Managing Director	Mechanical engineering skills	20+ years

The semi-structured interviews were conducted at each participant firm's premises. In several instances, the researcher was then invited to tour the manufacturing plant and view the operations. These tours were not formally included in the data gathering process and offers were only accepted as a means of enriching the interview experience. Elwood et al. (2007) claim that the interview site has an important role to play in qualitative research. It produces 'micro-geographies'<sup>11</sup> of spatial relations and

<sup>11</sup> In this context, a micro-geography refers to the specific manufacturing site where the research interview is taking place.



meaning which can offer sources of data that enable the researcher to enrich explanations offered by participants.

On one hand, the semi-structured interview enabled interviewees to provide responses on their own terms and to be free in the way they expressed themselves and used language. Both interviewer and interviewee participated in the interview, producing questions and answers through discourse. As Kvale and Brinkmann (2009) observe, the semi-structured interview needs to be flexible, accessible and capable of disclosing important and often hidden facets of human behaviour. Law et al. (1998) state that an interview is a narrative instrument that allows participants to tell stories about themselves that can be meaningfully positioned within the research. On the other hand, there were several limitations in adopting the semi-structured interview technique. For example, interviews were time consuming. The researcher first needed to make contact with the interviewee, then conduct the interview, transcribe and analyse the data and then make use of the information elicited. Nunkoosing (2005) also raises the issue of power in interviews, as the interviewer is the seeker of knowledge and the interviewee has power as the 'privileged knower'. It was often the case that the interviewee would provide responses to questions in a positive light only, ensuring the business was perceived as a model firm in transition. To gain a deeper insight, the researcher asked for examples and followed by attempting to draw out challenges and weaknesses as well as key strengths of the firm in transition. Similarly, an interview scenario requires participants to relay information 'on the day' of the discussion. Therefore, rather than seeking specific data sets, that would have required the participant to spend extra time searching for information, the interview was designed to capture the transition narrative of the firm at that point in time, based on experience, rather than specific firm statistics or quantitative information.

#### **2.3.4 Phase Four – City region focus groups**

Phase four involved the facilitation of three focus groups, one in each of the three city regions. For Kitzinger (2003), a focus group discussion stimulates a variety of ideas, informing the practices and behaviours that make up the socio-economic characteristics of that particular city region. Applying the focus group technique in this research enabled a variety of different intermediary actors to engage with the study and collectively discuss the drivers, barriers, policy insights and institutional agenda for

transition within each city region. The gatherings were planned to create a time and space to explore a topic, consider ideas and share personal understandings.

The researcher identified focus group participants who could represent the interests of economic, regional and industry development. It was essential to include a broad range of representatives to ensure a balanced social, political, economic and environmental insight was obtained. Again, the list of participants was reviewed by the researcher's regional contact to ensure all relevant stakeholders were invited to attend. Invitations to participate were subsequently distributed by email and, once accepted, participants were notified of the logistical arrangements of the meeting and questions to be addressed.

Seven participants took part in the Newcastle focus group representing the Australian industry Group<sup>12</sup>, Regional Development Australia Hunter, Hunter Business Chamber, Hunter Manufacturing and Research Institute, Hunternet and Lake Macquarie Council. The Geelong focus group included six representatives from the City of Greater Geelong, Geelong Business Chamber, Deakin University, Geelong Manufacturing Council, Clean Tech Innovations Geelong and a local consultancy firm. Nine participants were involved in the Wollongong focus group, representing the Wollongong and Shoalhaven City Councils, Department of Trade and Investment (Illawarra and Shoalhaven Offices), AusIndustry, Illawarra Business Chamber, Regional Development Australia Illawarra, University of Wollongong and the Australian industry Group. Burgess (1996) confirms the numbers represented across these three focus groups are ideal, given that too few participants per group – fewer than four – may limit discussion, while too many – more than 10 – may restrict the time available for individual participants to contribute. Stewart and Shamdasni (1990) similarly propose that a large sample, in many instances, is not required. Instead, when understanding particular nuances, attitudes and beliefs is the main objective for study, it is advantageous to explore a topic in a more intimate setting.

Each focus group was conducted in neutral surroundings to encourage participation and enhance trust. For example, both the Newcastle and Wollongong focus groups were held in independent conference facilities attached to the offices of the Australian industry Group, and were easily accessible to

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<sup>12</sup> The Australian Industry Group (Ai Group) is a peak employer organisation representing traditional, innovative and emerging industry sectors. Together with partner organisations, the Ai Group represents the interests of small and large businesses in sectors including manufacturing, construction, engineering, transport & logistics, labour hire, mining services, the defence industry, civil airlines and ICT.

participants from the central business district. The Geelong focus group was held in a waterfront venue, regularly used by city region stakeholders for meetings. Each focus group generally included people who knew each other and had worked together as part of individual regional development roles. The researcher adopted the role of facilitator, bringing facilitation skills from a background of professional workshopping. This experience assisted with building rapport amongst participants at the outset, enabling the process to progress through the component steps. Interaction between participants was a key attribute of the focus groups, with participants responding enthusiastically to the contributions of others and so triggering a chain of responses.

Each focus group gathering commenced with the researcher presenting the aims and scope of the research. Appendix D provides an example presentation from the Newcastle city region session. Next, while standardised questions were applied, each focus group was able to be somewhat tailored to the city region context, by using preliminary findings of the semi-structured interviews. Research questions remained open to provide an opportunity for participants to communicate experiences, ideas, values and practices with regard to sustainability and manufacturing in their region. Appendix E illustrates the focus group research themes explored. As new insights were gained across each group session, they were subsequently introduced into the next group discussion to progress the thematic dialogue and identify potential alliance patterns between the three city regions. As well as audio-recording the sessions, the researcher took notes, and after each focus group, generated additional notes by reflecting on the questions asked, the dynamics of the group and how the session flowed. Data were organised using NVivo data analysis software to theme and code each session and individual responses.

Although the focus group strategy described reflects the positive role focus groups play in data collection, Stewart and Shamdasni (1990) have identified several challenges with this method. These include: the potential for facilitators to introduce bias, by using body language to influence a response; facilitators losing control of the discussion, as a result of dominant participants within the group; the focus group not being representative of the actual participants themselves; and coordinating more than one focus group may complicate the collection and interpretation of data. The researcher was mindful of these challenges and all efforts to minimise these risks were taken. For instance, at the venue, the researcher was physically positioned at an equal distance to participants of the focus group to ensure

body language or mannerisms did not assume bias. The focus group sample had been checked by the researcher's regional intermediary contact to ensure relevant participants were invited to take part, and although multiple focus groups were organised, the interpretation of data was specific to the regional context at that point in time, minimising any complication or misinterpretation of information.

Nevertheless, there were added limitations with the focus group method. In all three city regions, industry intermediaries are by their very nature 'one-person-bands' and need to attend to a variety of agendas and tasks on any given day. Due to busy schedules and regional priorities, the numbers in the Geelong and Newcastle focus groups were not as strong as those in Wollongong. For example, on the day of the Geelong focus group, a well-known consultant was delivering another workshop, and in Newcastle, state ministers had organised an impromptu visit. As it was not possible to reschedule to include everyone, the researcher facilitated the focus group with those participants present on the day. The focus group questions were forwarded to those participants who could not be present, to provide them with an opportunity to respond. As a result, two participants in Newcastle and two in Wollongong provided comments via email with a follow up meeting conducted with the two Wollongong participants.

### **2.3.5 Phase Five – Customer semi-structured interviews**

Phase five involved selecting and recruiting original equipment manufacturer 'customers'. The initial aim of the study was to recruit five customers to participate in the research, based on a criterion sampling strategy (this number of firms was chosen to provide a benchmark for consistent recruitment numbers in each region for data gathering purposes). Customers needed to have headquarters located in Sydney (or nearby) or Melbourne, operate in clean technology and innovative manufacturing arenas, and engage in existing regional manufacturing supply chains. Following consultation with Australian CleanTech<sup>13</sup>, nine customers were recruited. Table 2.5 outlines the attributes of each case study customer as described by the sampling strategy. In addition, Table 2.5 highlights the multi-national corporation structure of selected customers, the number of employees in each organisation and the date the company was founded.

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<sup>13</sup> Australian CleanTech provides resources to help raise awareness of the clean technology sector and to provide the business case for transition.

Table 2.5: Attributes of case study customers

CUSTOMER	FOUNDED	APPROX STAFF	STRUCTURE/ LOCATION	INTERVIEWEE	HQ IN AUS.	PRODUCT/MARKET
C1	1958	12,000 global	MNC - US, Asia, UK	Sustainability Manager	Sydney	Property & infrastructure
C2	1973	3,146 global	MNC – US, Asia, Europe, Latin America	Sustainability Manager	Sydney	Design & manufacture modular carpet tiles
C3	2006	N/A	Australia (Subsidiary - US company)	Managing Director	Sydney	Design, supply geothermal heat pumps
C4	1999	6,350 global	MNC – US, Asia	Engineering & Procurement Manager	Sydney	Solar energy solutions design & construct
C5	2001	N/A	MNC - South Africa, UK, Europe, Japan, China	Previous Manager	Sydney	Manufacture solar energy solutions
C6	1981	2,800 global	MNC - 20 countries	Vice President Manufacture & Logistics	Sydney	Design & manufacture hearing technology implants
C7	1986	12+ 350 members	Australia	Chief Executive Officer	Sydney	Peak industry body for Mining, Equipment, Technology Services (METS)
C8	1847	348,000 global	MNC - Germany & Global	Head of Strategy for Power & Gas, Wind, Energy Mgt.	Melbourne	Power generation, Building tech., medical & healthcare, railway, mobility, engineering
C9	2002	16,000 global	MNC - Australia, NZ, US, Pacific Islands	Manager Product Innovation & Technology	Wollongong	Steel manufacturing, coated and building products

Notes: MNC (Multi National Corporation)

The researcher contacted the relevant business manager from each case study customer by phone or email, forwarded them a Participant Information Sheet and Consent Form and a meeting was organised. A one-on-one semi-structured interview between one and two hours was conducted with each of the nine customers. Two of the customers were based in Melbourne and the interview was conducted via Skype, as was one Sydney interview. Four of the Sydney based participant interviews were conducted on-site at the address of the customer, and two were held in café facilities close to the customer's office location for ease of access and time. Interview guidelines were designed to identify the supply chain attributes customers determined were key to fulfilling the requirements of sustainability related projects. Appendix F outlines the interview questions.

## **2.4 Research reflection and data analysis**

As Table 2.1 shows, Chapters 3 to 6 employ qualitative discourse, cross-case and case study data analyses. More specifically, Chapter 3 includes a meta-review of four separate but related bodies of literature - Advanced Manufacturing, Sustainable Transitions, Regions are Spatial and Transition Regions - to identify gaps in research to date and build an integrated theoretical framework for practical application within the manufacturing sector. Chapter 4 employs a cross-case study and qualitative fieldwork approach to explore the sustainable transition attributes of 24 traditional manufacturing firms. Chapters 5 and 6 apply a comparative case study approach to determine the spatial transition attributes within each city region and the perspectives of selected original equipment manufacturer customers.

Although prior studies have employed similar qualitative methods (Bos, Brown and Farrelly 2014; Loorbach and Wijsman 2013; Nevens et al. 2013; Novotny and Laestadius 2014; Tripp and Otto 2009), these contributions predominantly are based on singular cases with minimal cross-case analysis. For example, Loorbach and Wijsman (2013) combine insights from literature with an experimental case study in the Netherlands roofing sector. In this action research project, Loorbach and Wijsman (2013) trialed the 'business in transition' framework by translating and applying principles underlying the strategy of transition management to the case study context. This study was explorative and the analysis, based on semi-structured interviews with representatives involved in the business. This case study also illustrated the possibilities of the transition management approach in a business context and for sectoral change. However, what the study does not show, is whether the approach can be applied

more generally or whether it was successful in stimulating a longer term transition. In a second example, Bos, Brown and Farrelly (2014) present an empirical single case in the Australian urban water sector. The authors describe the case study as a valuable socio-technical context for examining such transitional change processes and shifting routines held by multiple traditional actors. To determine whether the case could be considered a suitable proxy for examining a transition management process, multiple empirical data were collected, analysed and mapped against the five elements of transition management. This involved collecting data from 17 semi-structured interviews, 12 focus groups and process observations, to investigate the features and dynamics of the urban planning process. Whilst the study did not present a radical change across the sector, it did provide an empirical foundation for understanding how attributes of transition management processes can be applied to future change management initiatives. In a third scenario, Tripl and Otto (2009) move somewhat closer to contributing a cross-case analysis by comparing two industrial regional renewal scenarios and drawing on empirical evidence, obtained via in-depth interviews, with regional actors and telephone surveys of cluster firms and institutions. Applying this approach, Tripl and Otto (2009) provided an insight into the critical factors that differentiated the two regions based on firm, knowledge-infrastructure, network-institutional and policy dimensions.

Whilst the three aforementioned studies provide comparable and alternative methods for exploring the attributes of a sustainable transition in different system contexts, there are also similarities with this research. For instance, section 2.3.1 and 2.3.2 both substantiate the benefits of employing the semi-structured interview and focus group process used by the above scholars. These methods provide a valuable means for investigating transition dynamics at the firm and system level and in exploring the nuance and narrative of such transition practices. In addition, the case study examples also illustrate the value of case study research in building or testing theory. Yin (1994) proposes that case studies are rich, empirical descriptions of particular instances based on a variety of data sources, and Eisenhardt (1989) claims that the evidence from multiple cases is perceived as more compelling and relevant for theory testing and building. The cases presented correspond with Yin (1994) by using real-life settings that focus on organisational and managerial experiences and agendas, which are critical and intelligible only within the social and cultural context of the particular industry. In this thesis, four case study settings are analysed: the firm, industry sector, city region and the customer. As such, this

thesis builds the Attributes of a Sustainable Transition conceptual framework from multiple case examples, and positions the theory in the wider context of social science and transition research.

Data analysis specifically employed the steps of ‘within-case analyses’ and ‘cross-case pattern search’. Within-case analysis involved case study write-ups for each site. The application of a cross-case search then enabled the data to be viewed for emerging patterns across the cases; highlighting similarities, differences and new dimensions (Eisenhardt 1989). The initial research aims, variables and constructs, identified from the literature guided the research process and the format of data-gathering questions. This deductive approach was then informed, reshaped and tested inductively by ideas and themes emerging from the data. Discussion outcomes were audio taped, transcribed verbatim by the researcher, organised, coded and themed using qualitative data analysis software, NVivo and discourse analysis. When conducting discourse analysis, coding serves two primary functions – organisation and analysis-interpretation of text (Waitt 2010). Due to the number of interviews conducted, five descriptive coding categories (Foucault 1972) were used throughout Chapters 4, 5 and 6 and organised in NVivo:

- context (where, when and who participated in identifying transition attributes),
- practices (events, activities, opportunities, challenges - what happened as part of the transition process, who was involved and how was it carried out),
- action (what the participant did or did not do when in transition),
- attitudes (statements of judgments about the transition process, manufacturing supply chains and the global and national context), and
- experiences (statements of feelings and emotions about sustainability and manufacturing or interactions with other stakeholders and network opportunities).

Multiple codes were applied to one section of text which allowed for emergent themes to be highlighted through the quotations of participants. Each theme illustrated how a particular experience or discourse was deployed to make sense of the manufacturing transition. The Attributes of a Sustainable Transition conceptual framework was then able to be systematically tested, compared and contrasted with the theory and data, subsequently building towards a model to accurately reflect the results. By implementing the research design described in this chapter, the researcher has been able to address the



thesis aim and individual chapter research questions.

The case study findings present the challenges and opportunities of single firm sustainable transitions, whilst at the same time, offering potential insight into how multiple case studies can be aggregated to represent broader system level attributes. This is achieved by selecting categories or dimensions of transition processes (as in Chapter 4 where the four key dimensions of transition management have been applied) and then looking for within-group similarities, coupled with intergroup differences (Eisenhardt 1989). By applying the Attributes of a Sustainable Transition theoretical framework, these multiple dimensions of transition can then be captured at the broader system level.

## Chapter 3

### **Identifying attributes of a sustainable transition for traditional regional manufacturing industry sectors – a conceptual framework**

This chapter presents a meta-review and analysis of relevant literature, integrating four existing bodies of work: Advanced Manufacturing, Sustainable Transitions, Regions are Spatial and Transition Regions to introduce the ‘Attributes of a Sustainable Transition’ theoretical framework. The text below is based on the published paper: Skellern, K, Markey, R and Thornthwaite, L, (2017). Identifying attributes of a sustainable transition for traditional regional manufacturing industry sectors - a conceptual framework. *Journal of Cleaner Production*, vol. 140, pp. 1782-1793.

Author contributions:

Ms. Katrina Skellern was responsible for the design of the research, data collection, analysis and write-up of this chapter. Professor Ray Markey and Associate Professor Louise Thornthwaite provided assistance with research design and supervision as appropriate for a thesis by publication authorship.

For consistency and cohesiveness within this thesis document, the following modifications have been made: the paper Abstract has been moved to Appendix G; the References have been incorporated into a single list of sources at the end of the thesis; and additional comments linking this chapter with the next are added at the end.

#### **3.1. Introduction**

The world is experiencing challenges within two critical and interrelated dimensions of sustainability – economic and environmental. These challenges include the impacts of climate change, environmental forces and future energy generation, coupled with the global competitive pressures on manufacturing in developed economies. Traditional economic development strategies are struggling to navigate the maze of these concerns. In addition, applying sustainability is not yet common practice in business, particularly within the manufacturing sector. Typically, sustainability is seen as a cost, something that would be good to do for the environment or to tick the ‘green’ box of a customer contract rather than a fundamental component of ‘doing business’. Nevertheless, significant opportunities await those firms

willing and able to change. Consequently, within the context of traditional manufacturing, a transformation is slowly taking place, reshaping the way industries are configured and paving a route towards a new sustainable economy.

A plethora of scholarly literature focuses on the business transition towards a 'green' or sustainable economy. These contributions mainly focus on technological and market driven approaches. For instance, Mol and Sonnenfeld (2000) introduced the concept of Ecological Modernisation based on the premise that ecological degradation could be fixed by institutional, technological and policy solutions. The development of the Green Car Innovation Fund (Goods, Rainnie and Fitzgerald 2015) in Australia's automotive sector is an example of 'weak' Ecological Modernisation, a top down approach attempting to provide an ecological fix (Gibbs 1998). Second, Kemp (2010) pioneered the concept of Eco-Innovation as the development of products or processes that reduce negative impacts of resources used. Innovations in clean coal technology aimed at cutting carbon emissions are an example (Nill and Kemp 2009; Miranda et al. 2011). Both approaches have been critiqued for their technological focus and neglect of the social and spatial setting, with scholars arguing for a more integrated approach that includes analysing the social dimension and impacts of technology (George, McGahan and Prabhu 2012).

Alternatively, market driven approaches such as Corporate Social Responsibility (CSR) have focused on internalising costs associated with production such as pollution, to reduce the environmental footprint of organisations (Siegel 2009). For example, Martinez et al. (2012) showcase how Adnams Brewery in the UK adopted eco-friendly values to 'green' the business and its products. However, it is difficult to measure the tangible benefits of CSR which are often isolated from core business and generally used as a marketing tool (Siegel 2009). Similarly, emissions trading uses a property rights approach to incentivise individuals to protect the environment. Theoretically, increasing an individuals' understanding of their responsibilities for common property, in this case, the quality of the environment, will motivate them to modify the impact of environmental harm on the atmosphere. Arguably, within a specific regulatory framework, the market then determines the most efficient method of controlling pollution. Yet, with so many variations on emissions trading systems

(Parliament of Australia 2010), debate surrounds their durable effectiveness in reducing carbon pollution (Garnaut 2011).

Over the last decade, a socio-technical systems approach towards sustainable transition research has emerged within the field of evolutionary economics (Nelson and Winter 2009), complex systems theory (Kauffman 1995) and socio-technical systems theory (Trist 1981; Rip and Kemp 1998; Geels 2002; Loorbach and Rotmans 2010). Of particular relevance here, is the link with one of evolutionary economic geography's master concepts, path-dependence, which emerged from research in manufacturing and industrial districts in the 1980s and 1990s (Cooke 2009). The concept of path-dependence tends to lead firms to create strategies to optimise existing capital investment and technology. For many decades, economic and industrial development policy has focused on this somewhat narrow specialisation philosophy (Cooke 2009). The issue of how to drive and coordinate a transition in this sector towards sustainability is now receiving increasing attention in policy and scholarly forums (Cooke 2009; Gibbs and O'Neill 2014). As a consequence, this chapter argues for a more diversified policy approach that enables a fundamental shift towards long-term sustainable change and a shift from unsustainable modes of operating towards sustainable alternatives within a socio-technical system. Such a move requires a holistic analysis within the traditional manufacturing sector of relevant socio-technical characteristics, including user practices, business models, value chains, organisational structures, regulations, spatial dimensions of knowledge spill-overs in related sectors and regional proximity attributes, institutional and political structures.

The aim of this chapter is to integrate existing bodies of literature to introduce an interdisciplinary conceptual framework, 'Attributes of a Sustainable Transition' that contributes to the policy call for sustainable development. Development of the framework is part of a larger study to identify the elements associated with sustainable transitions, within a traditional regional manufacturing setting. Rather than considering the elements of one theoretical approach in isolation, this framework reviews and incorporates four concepts. These include: Advanced Manufacturing (Green and Roos 2012; Roos et al. 2014; Wilcox 2014), Sustainable Transitions (Kemp 1998; Geels 2002; Geels and Schot 2007; Markard, Raven and Truffer 2012; Lachman 2013), Regions are Spatial (Massey 1979; Hudson 1999;

Cochrane 2012; Gibson, Carr and Warren 2012) and Transition Regions (Enright and Roberts 2001; Cooke 2009; Horwitch and Mulloth 2010; Amison and Bailey 2014; Gibbs and O'Neill 2014).

To develop the proposed integrative framework, this chapter is divided into five sections. In section 3.2, the need to transition towards a sustainable economy is explored. Section 3.3 considers the importance of manufacturing, based on the Australian context. The differences between former and potential future manufacturing approaches are explored. Section 3.4 introduces the four elements of the conceptual framework – Advanced Manufacturing, Sustainable Transitions, the often regional nature of sustainable transitions in manufacturing and the significance of the spatial lens. This latter element supports the need to understand the path-dependent, related variety and proximity characteristics for regenerating the traditional manufacturing industry sector.

### **3.2. What is a transition?**

Scholars have articulated the meaning of a 'transition' in a variety of ways. Within the field of sustainability and economics, Pisano, Lepuschitz and Berger (2014) consider a 'transition' as the smaller pieces of the transformation phase. Political science scholars such as Davies (2013), argue a transition involves the bigger picture, incorporating social, political, economic and cultural change. Transition scholars typically define the term holistically as involving a range of dimensions including, technological, material, organisational, institutional, political, economic and socio-cultural (Geels and Schot 2007). In contrast, human geographers such as, Hicks (2014, p.7) consider a transition to be evolutionary, 'the process of adaptation, whereby an organism becomes better able to live in its habitat'. Rather than abandon these meanings in search of another term, together, they contribute to a fundamental shift towards a new sustainable trajectory.

#### **3.2.1 The need for transition**

The need for transition to a sustainable economy is not without challenges. Diesendorf (2014) suggests, the concepts, green, low carbon, ecological and sustainable are contestable. Arguably, this perceived dispute has not been because a global society has failed to strive for a more ecologically balanced economy. Rather, the contest reflects the current rhetoric of political and dominant industry stakeholders, threatened by how the transition discourse challenges the status quo and neo-liberal policy agendas. A benchmark survey in Australia, for example, revealed that whilst two-thirds of Australians

accept climate change is real, 89.0 per cent of those surveyed believe that humans bear some responsibility for climate change, and 71.0 per cent agree that tackling climate change creates jobs and investment in clean energy for a sustainable future (The Climate Institute 2013). Diesendorf (2014) argues that the current orthodoxy embedded in everyday workings of government and daily lives, alienates the environment and denies a progressive and socially just transformation (Kelsey 2014). The result has been to stymie any fundamental shift towards a sustainable economy.

### **3.3. Does manufacturing matter? – An Australian perspective**

Manufacturing once made a vital contribution to Australian economic development, producing ample goods to supply domestic needs (Milne 2010). However, in recent decades it has been in a well-documented decline. Current Australian political and scholarly debates tend to focus on whether Australia should manufacture at all (Gibson, Carr and Warren 2012). Following the loss of the large car and steel production facilities in recent times, for instance, Ford and Toyota have now committed to cease vehicle production in their Victorian plants by 2017 (Dowling 2014). BHP Newcastle closed its steelworks in 1999 and BlueScope Steel in Port Kembla has been reducing domestic steel production since 2010, decommissioning one blast furnace in the process. These closures not only impact the existing industry and its current workforce, but also, the supply chain businesses and regional communities surrounding them.

Interdisciplinary scholars within geography, including, Hudson (2000), Milne (2010), Gibson (2012), and Mazzarol (2014) along with management scholars and the Australian Government (2012) provide accounts of the history of manufacturing and the onset of decline. From the 1940s, government interventions such as, a borderless national market, tariff protections and large scale investments in production particularly in defence, enabled Australia's small manufacturing sector to grow rapidly. By the late 1950s, manufacturing accounted for 29.0 per cent of Australian GDP (Milne 2010). However, by the mid 1960s, this level of growth proved unsustainable. Australia's land wealth, minerals and low taxes, combined with large scale production, high wages and numerous deskilled and unskilled jobs (Hudson 2000), created symptoms of unbalanced growth, widening income gaps, disrupting communities, closing plant and dislocating workers and families (Milne 2010). Subsequently, labour productivity growth slowed and profits fell (Milne 2010). Although these factors delivered wealth and

employment growth to globally linked cities like Sydney, it produced challenges of economies of scale in manufacturing and industrial regions like Newcastle, Wollongong, Geelong and the western suburbs of Sydney and Melbourne.

Between 1980 and 2013, the manufacturing sector's contribution to GDP fell from 29.0 per cent to 6.8 per cent and declined as a share of total industry gross value add (GVA). Similarly, its share of total employment dropped from 16.8 per cent to 8.1 per cent (Milne 2010). Figure 3.1 highlights the manufacturing sector's share of total industry GVA has declined from 16.0 per cent in 1986 to 10.0 per cent in 2011 compared to the mining, services and agriculture sectors (Australian Government 2011).

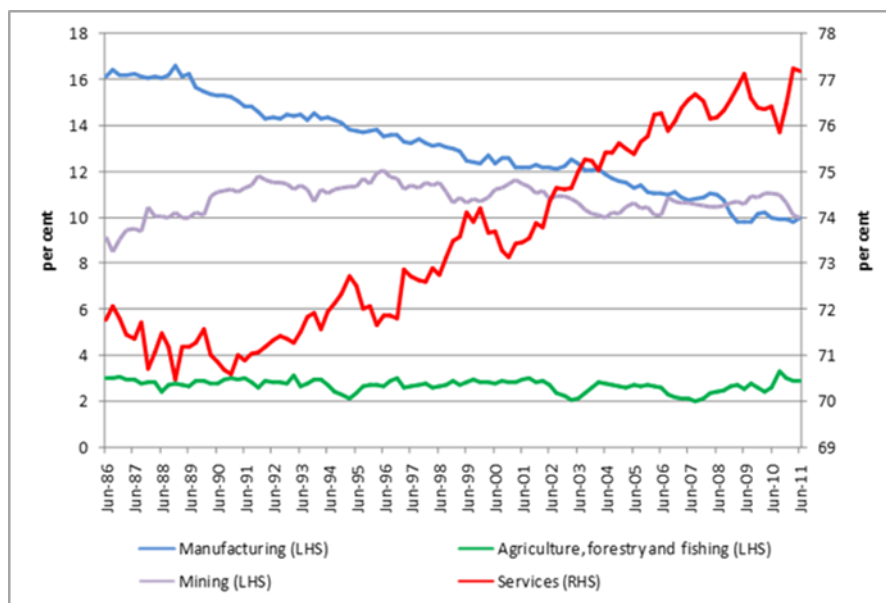


Figure 3.1: Australian Manufacturing Sector GVA 1986 - 2011 (Australian Government 2011)

Whilst Weller and O'Neill (2014) acknowledge that global factors are contributing to the decline of Australian traditional manufacturing, they argue that the current economic reliance on resource extraction has limited a strategic and radical shift towards innovation in the manufacturing sector and discouraged other types of activity requiring advanced skills.

Utilising the Economic Complexity Index (ECI) to measure Australia's manufacturing performance with the rest of the world however, Roos et al. (2014), establish that Australia is positioned at number 79 with an ECI of -0.3. Roos et al. (2014) observe that, while it is sophisticated, high value manufacturing that tends to increase a country's ECI, current traditional Australian manufacturing is predominantly low cost, low margin and high volume. These measurements illustrate that,

manufacturing activity is critical for a country to capture value from economic activities, underpinning its ability to grow employment, GDP and competitive value. Accordingly, existing manufacturing models need to adapt to compete in a global production network.

It could be argued that a blurring of the present picture of Australian manufacturing is contributing to current debate on the future of the industry and its economic comparison to other sectors. First, the perception of the sector as less important than a growing services sector and a changing resources (mining) sector is misguided. The Future Manufacturing Industry Innovation Council (Australian Government 2011) claims that manufacturing contributes five times more than the mining sector to total employment. In 2011, manufacturing employed almost one million people (8.5 per cent of the workforce) and mining around 200,000 people (1.9 per cent of the workforce). Furthermore, the manufacturing sector has an indirect multiplier effect, each dollar worth of manufactured goods creating another \$1.43 of economic contribution towards other sectors, double that of the services sector (\$0.71) (US Bureau of Labour Statistics 2015). On this basis, Christopherson et al. (2014) appeal for Government to support a domestic manufacturing base, arguing that positioning the services sector to fill the gap of manufacturing will result in reduced investment in plant and research, reinforcing the demise of local manufacturing.

Second, Wilcox (2014) illustrates, that whilst domestic challenges in the last two decades contributed to a declining share of manufacturing in the economy, this did not prevent growth in absolute terms. However, global encounters over the last decade have influenced output growth. For example, the growth of China's industrial output, particularly in steel and primary aluminium production (Figure 3.2), has increased competition, reduced prices and displaced production elsewhere, forcing Australian industry to adapt.



**China's manufacturing output grew by > 14% pa  
(and overtook Japan's and the US's)**

**Manufacturing Output, Top 5 Countries  
Current U.S. Dollars, 1970-2010**

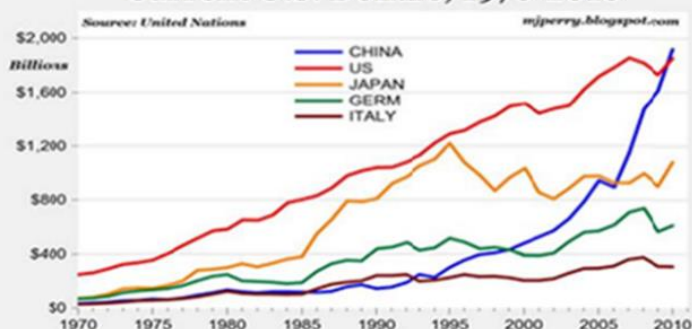


Figure 3.2: China's industrial output growth (Wilcox 2014)

A further factor is Australia's experience with a decade of high currency rates. Although, currently lower, at its highest, the \$AUD was 55.0 per cent above the \$USD average, equivalent to an increase in total costs for export or import-competing businesses of between a quarter and a third. Similarly, the increasing cost of energy, particularly for energy intensive manufacturers, and Australia's growth in unit labour costs growing faster than other developed countries (Figure 3.3), combined, have increased costs for Australian firms, inhibiting global competitiveness.

COUNTRY	CPI % CHANGE	MANUFACTURING HOURLY LABOUR PRODUCTIVITY	UNIT LABOUR COST
	Average Annual % Change 2000-2009	Average Annual % Change 2000-2010	Average Annual % Change 2000-2010
UNITED STATES	2.50%	5.18%	-1.41%
SWEDEN	3.00%	4.42%	-1.01%
FINLAND	1.82%	4.54%	-0.99%
GERMANY	1.60%	1.82%	0.23%
CANADA	2.00%	0.89	1.63%
<b>AUSTRALIA</b>	<b>3.00%</b>	<b>1.93%</b>	<b>2.48%</b>

Figure 3.3: Australia's unit labour costs (Green and Roos 2012)

### 3.4. What does the future of manufacturing look like – a conceptual framework?

This chapter now turns to the four existing scholarly contributions which will contribute to development of the Attributes of a Sustainable Transition conceptual framework. This will facilitate examining the attributes that characterise a fundamental shift towards a sustainable economy within the traditional manufacturing sector.

#### 3.4.1 Advanced Manufacturing

The first element contributing to the Attributes of a Sustainable Transition framework is the concept of Advanced Manufacturing. This field of speciality builds on the work of Roos et al. (2014), who highlight that traditional manufacturing requires a shift from technological to include non-technological innovation. In contrast to traditional manufacturing operations which concentrate on the ‘making of things’, an advanced manufacturing model encompasses the whole chain of activity from research and development to end-of-life management. Table 3.1 highlights the non-technological attributes in advanced manufacturing models which are absent from traditional models.

Table 3.1: Comparison of traditional and advanced manufacturing approaches (Roos et al. 2014)

<b>Firm Strategies</b>	<b><i>Traditional</i></b>	<b><i>Advanced</i></b>
<b>Business model</b>	<i>High volume, low cost</i>	<i>Low volume, high value</i>
<b>Skills</b>	<i>Low tech., production focus</i>	<i>High tech., service and niche focus</i>
<b>Collaboration</b>	<i>Knowledge in-house</i>	<i>Knowledge sharing, highly collaborative</i>
<b>Value add</b>	<i>Compete on internal strengths</i>	<i>Compete value for money, customer oriented</i>
<b>Technology</b>	<i>Producing goods only</i>	<i>Technological &amp; non-technological</i>
<b>Innovation</b>	<i>Resource efficiency</i>	<i>Design efficiency</i>
<b>Value chain</b>	<i>Energy intensive, large waste stream</i>	<i>Sustainable product &amp; processes</i>

These include: new business models and production methods, collaboration, development of high performance work organisation and management capabilities. Similarly, Kordamentha’s (2013) research demonstrates, that an advanced model of manufacturing thrives on business innovation and flexibility to deliver solutions as well as products, embraces customisation and builds networks of knowledge and relationships. Brynjolfsson and McAfee (2014) refer to this model as part of the

‘second machine age’. The first machine age being the onset of technological innovation and improvements to modern life. The second machine age complements the physical power of technological progress and development with mental power, and digital advances that push our brains and shape our environments through artificial intelligence, computer and robotic technology including driverless cars and 3D printing. Subsequently, Green and Roos (2012) claim that the addition of advanced manufacturing to the stand-alone physical fabrication process in Swedish and German manufacturing, was the most significant source of output improvement, contributing 20.0 per cent of productivity growth. However, a key limitation with the advanced manufacturing approach, is it fails to capture how the need for profit and creation of jobs can be balanced with a greater understanding and application of sustainable values. As a singular concept, advanced manufacturing does not go far enough. Therefore, a sustainable transition approach aims to complement an advanced model of manufacturing. It is to this point that the next section turns.

### **3.4.2 Sustainable Transitions**

Manufacturing change and evolution are not new. Thus, a sustainable transition poses significant opportunities and challenges for a future manufacturing sector. On one hand, Qian (2014) advocates that sustainable manufacturing presents resource savings, through production efficiencies, ecologically sensitive design and cleaner production leading to fresh opportunities along the value chain (United Nations Environment Program 2014a). Hence, Davies (2013) positions a shift to a sustainable trajectory as a mechanism for reshaping the way manufacturing industries are organised. These principles imply a shifting ideal, from the sole trade of artefacts to that of a range of intelligent products and services that add value to existing functions (Jovane and Westkämper 2009).

On the other hand, when linking production values with consumption behaviour, Jovane and Westkämper (2009) propose that increasing public awareness of environmental pressures and the demand for technological and social solutions, positions manufacturing as a main enabler, at the forefront of change. As Fingleton (1999) argues, the world’s consumers will increasingly insist that goods are made in the most environmentally friendly ways possible. Consequently, manufacturers who can adapt processes and products to the needs of a sustainable economy will have a competitive advantage, at the same time systematically supporting a sustainable future.

Yet, much of the literature misses the challenge and realisation of how to achieve this transition and the manufacturing industry's contribution to it. In Australia for example, current industry policy initiatives to facilitate a sustainable shift have had limited success. For instance, the drive to transform Australian car manufacturing into a sustainable industry through mechanisms such as the Green Car Innovation Fund, ultimately became a form of financial assistance to retain domestic car production, with limited evidence of actually 'greening' the industry (Goods, Rainnie and Fitzgerald 2015). One gap within this conversation is a recognition of the uncompensated environmental effects of production and consumption, such as waste, pollution and emissions that currently remain external to the manufacturing process. Manufacturing firms have historically regarded environmental and sustainable concerns as a threat and extra cost, keeping them outside core business. Doganova and Karnoe (2012) articulate the need to qualify this gap, transforming concern into value.

A sustainable transition integrates the environment value stream in the socio-technical system. It aims to reconfigure the manufacturing firm within a nexus of governance, technology and practice. Hence, by combining sustainable transition theory with advanced manufacturing concepts, socio-technical transitions do not just change the structure of the existing system, such as manufacturing production, they also affect societal domains such as planning and policy making and the dominant way in which and what a firm produces (Geels 2011).

Although a number of scholars have contributed to the development, application and growth of sustainable transition theory (Kemp 1998; Rotmans, Kemp and Asselt 2001; Geels 2002; Geels and Schot 2007; Markard, Raven and Truffer 2012; Lachman 2013), empirical evidence on practical transitions and attributes that contribute to successful approaches are largely absent, particularly in an Australian context. Geels (2011) suggests that this is due to naivety and inherent scepticism of government, industry and society, influenced by the perception that environmental and economic problems are slow to materialise and therefore, not urgent. Kemp and Loorbach (2003) maintain that, because transitions towards a sustainable economy are incremental and involve multiple solutions rather than 'silver technological bullets' they are placed in the 'too hard basket'.

These scholarly contributions push the boundaries of sustainable transition theory towards new research areas, well suited for application to manufacturing transitions. For instance, Jovane (2008) suggests,

whilst market forces drive competitiveness as the dominant standard of economic development, a sustainable transition framework facilitates a more wide ranging shift in economic and also social, environmental, geographic and technological characteristics. For example, Tyfield et al. (2014), who analysed China's adoption of renewable forms of energy, found that China's growth in renewable energy was characterised by a technological focus, but was not affecting the kinds of system innovation processes needed for a sustainable transition. Rather, technological change was only one element in a broader socio-technical transition involving change to social practices, norms, infrastructure, technological knowledge, networks and culture. To investigate attributes of sustainable transitions, scholars have identified two main heuristic frameworks including, the Multi-Level Perspective and Transition Management.

#### **3.4.2.1 Multi-Level Perspective**

The multi-level perspective is a multi-dimensional model enabling recognition of interactions and timing between levels of analysis to identify possible pathways for change. In this context, from one manufactured product or service to a more sustainable one (Geels 2002). The multi-level perspective originates from evolutionary economics (Nelson and Winter 2009) and social construction of technology theory (Hughes 1987; Bijker et al. 2012) and includes three analytical levels (Figure 3.4) (Rip and Kemp 1998; Geels 2002). The landscape level considers macro elements and global trends such as climate and population growth (Geels 2002). The regime level explores interactions between dominant actors, systems and rules, often maintaining the existing regime and resisting change, resulting in the entire system remaining path-dependent on current practice (Geels 2004). The niche level facilitates innovative activity and new path creation within the firm towards destabilising the mainstream (Berkhout et al. 2010). Figure 3.5 highlights these forces of change within the manufacturing sector.

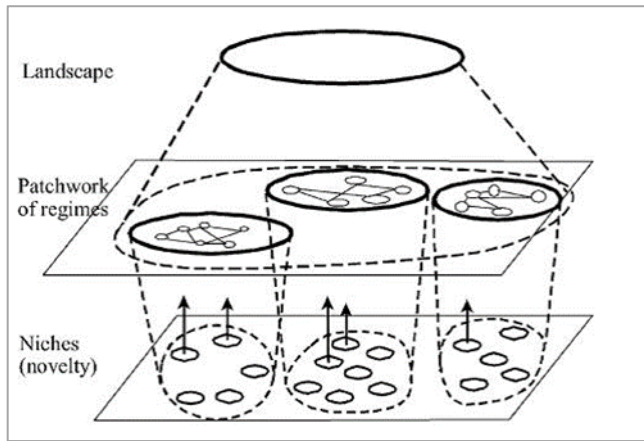


Figure 3.4: Three levels of the multi-level perspective (Geels 2002)

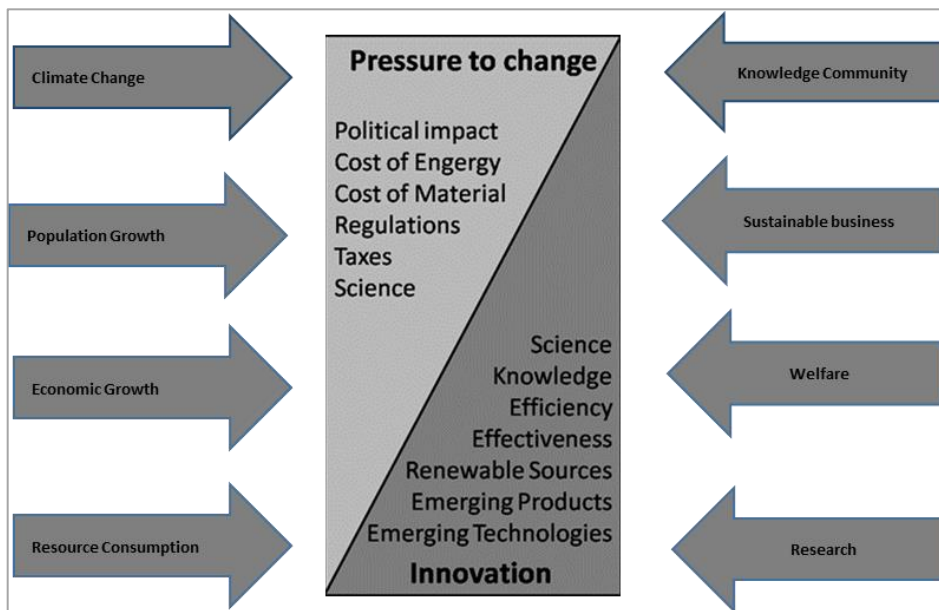


Figure 3.5: Forces of change in the manufacturing sector (Jovane 2008)

The multi-level perspective has been applied to the analysis of a range of contemporary transitions of sustainability, including, electricity systems (Verbong and Geels 2007; Hofman and Elzen 2010), mobility and green care (Van Bree, Verbong and Kramer 2010; Geels et al. 2011), organic food and sustainable housing (Smith 2007) and resource recovery (Jackson, Lederwasch and Giurco 2014). However, Shove and Walker (2007) criticise the multi-level perspective as being distanced and idealistic and for Smith, Voß and Grin (2010), its boundaries are too vague and complex. Within the Attributes of a Sustainable Transition conceptual framework, the multi-level perspective enables a practical analysis of cultural norms and values as well as unpacking the technological elements of sustainable product development - specifically the ‘what’ of sustainable transitions.

### 3.4.2.2 Transition Management

The second heuristic framework identified within the sustainable transition literature is that of transition management, which originates from Technological Transitions, Complex Systems Theory (Kauffman 1995) and Governance approaches (Rotmans, Kemp and Asselt 2001). Transition management presumes actors can influence large scale change and direction through a variety of actions including: experimenting and learning, gaining stakeholder input, bringing networks and actors together, continuous reflection and coordinating strategic and operational programs (Lachman 2013). However, the empirical insights of transition management remain limited, particularly in Australia. One exception based on research by Bos, Brown and Farrelly (2014), examines the socio-technical change process in the embedded routines of multiple actors towards sustainability within the water industry. Viewing transition management within the Attributes of a Sustainable Transition conceptual framework, explores levels and strategies of actors that can influence and coordinate the transition - specifically the 'how' of sustainable transitions.

Table 3.2 summarises the first two concepts of the Attributes of a Sustainable Transition framework, discussed so far, demonstrating whilst an advanced manufacturing approach shares several attributes with sustainable transition theory, a transition framework embeds sustainability within the core values of the organisation, enabling a fundamental shift within the existing system and regime. Whilst future manufacturing models rely on the need to compete in a global context, advanced manufacturing, with its focus on mass customisation rather than mass-production, requires innovation in niche markets. Within such a market, solving new environmental problems is an opportunity, and the sustainable transition approach provides the theoretical elements to guide such adaptation. However, because research on both advanced manufacturing and sustainable transitions has largely focused on the level of nation states, Europe and large organisations, it has neglected to recognise the significance of geographic and spatial attributes within a manufacturing transition that are linked to regional context. Section 3.5 and 3.6 focus on addressing these omissions.

Table 3.2: Comparison of advanced manufacturing and sustainable transition concepts (Gibbs and O'Neill 2014; Roos et al. 2014)

<b>Advanced Manufacturing (Similarities with sustainable transition theory)</b>	<b>Sustainable transition theory (additional elements)</b>
Technological/non-technological	Integration environment/innovation
Niche focus, systems and models	Socio-technical system
Collaborative	Redevelop labour/capital in new sustainable sectors
Innovative	Strategies towards sustainable system
Absorptive knowledge capacity, new business models, systems integration	Social norms value sustainability
Introduce new skills/routines	Integration sustainability into core economic decision processes
Understanding customer/user practices	Reduction capital costs for sustainable infrastructure investments
Building new markets	Landscape, regime and niche levels
Culture for change in peripheral locations, legacy of past industrial practices	Metric guiding sustainable transition Experimenting, learning, reflection, engaging actors/agencies

### 3.5 Regions are Spatial

A growing body of research is considering the region as an important spatial context for sustainable economic development. This research suggests that understanding why some regions perform better than others is essential, if regional communities are to make sound decisions about their economic, social and environmental future. Yet, the region often has contested meanings. From a policy perspective, the term ‘region’ refers to administrative and political jurisdictions, enabling program initiatives, service delivery and planning strategies to be accounted for via physical place. For example, to identify governmental boundaries, the Australian Bureau of Statistics (2011a) considers demographic and socio-economic factors when collecting Australian geographic data. Geographers such as, Beer, Maude and Pritchard (2003, p.43) define the region as ‘a grouping of nations, an area smaller than the nation or sub-national region or simply an area outside the capital cities’. Arguably, these region references encompass physical characteristics of space and statistics, whilst missing other important socio-cultural attributes that contribute to the make-up of place. Hansen and Coenen (2015), argue



whilst there is wide agreement that place-specificity matters, there is still little knowledge about how it matters for transitions. This chapter aims to respond to this call.

Beer, Maude and Pritchard (2003) claim physical delineation has been exacerbated by global and national concepts of present day economics, positioned within neo-classical and capitalist thinking. This thinking has dominated regional and national development or as Bourdieu (1998, p.95) suggests, 'the common-sense of our time'. A growing body of research is unpacking these orthodox economic approaches in search of alternative policy agendas. For example, Granovetter (1985) and Stilwell (2009) emphasise social embeddedness, institutional connections and the 'messiness' of everyday life, are attributes that drive and shape realistic market outcomes and regional economic policy, which are missing from traditional principles. Similarly, Peck and Tickell (2002) argue classical economic approaches are the cause of regional disconnection, one size fits all models and particular path-dependencies, normalising 'growth first' approaches. As a consequence, the regime often remains unchallenged and regional innovative economic development opportunities limited. In recent times, geographers have been engaging with issues of sustainable transitions in search of new models, due to emerging policy attention for a shift of post-industrial reconfiguration and regional policy, in search of new models (Truffer, Murphy and Raven 2015).

### **3.5.1 Rethinking the region – space and place**

Rethinking the region beyond physical boundaries comprises four aspects. First, conceptualising place as bound in a network of relationships, demonstrates multiple differences that counter the 'one size fits all' approach. For instance, Massey (1979) paved the way for a prominent field of geographers such as, Peck (1996), Allen, Massey and Cochrane (1998), Hudson (1999), Morgan (2004), Cochrane (2012), Gibson, Carr and Warren (2012), Truffer, Murphy and Raven (2015) and Hansen and Coenen (2015), to rethink assumptions about space and how regions are positioned. Massey's (1979) work on the importance of place having multiple identities, as a process rather than a frozen place in time, calls for an analysis of spatial relations between actors and institutions in regions. This approach is key to understanding economic and political dynamics, power relationships, marginal voices (Truffer, Murphy and Raven 2015), and the things that actually happen in regions. Hansen and Coenen (2015) similarly emphasise, the social production of space is constructed through social interactions between actors.

This is becoming an increasingly important dynamic within global production networks, where proximity of clusters and industrial districts influence development of new interfirm relationships and collaborations. Truffer, Murphy and Raven (2015) point out, a consistent trend in transitions literature has been to apply a national focus to understand industry dynamics and shifts when designing clean-technology industry policies, which in many contexts lacks legitimacy. Other frames and scales for understanding these shifts are warranted.

Second, place consists of a network of relationships between different scales of socio-economic activity. For instance, McGrath-Champ (2001) argues that the traditional regional development level of scale, self-contained analysis, should be replaced with social life as practice across interconnected levels. In this way, scale brings life to space and place on all levels. Similarly, Brenner (1998) and Truffer, Murphy and Raven (2015) observe that spatial scales are not collective units of space defined by a certain size, but encompass social levels enabling the firm, region, nation and international network to be explored between scales, as well as examining relationships within them. A review of the literature also points to debate about the appropriate level of analysis. Peck (1996) argues that the local or regional level of enquiry is essential since national policy is shaped by institutions in regions and communities. For instance, Brown and Deem (2014) found that 56.0 per cent of Australian citizens identified as being 'more' from their region than their state. This evidence resonates with Rotmans (2014), who suggests that regional scale is becoming more important, as citizens become actively engaged at local levels in building social cohesion, economic sustainability and political trust.

Additionally, a spatial lens demonstrates the strength of the regional scale in rethinking and shaping industrial policy for reindustrialising regions. Christopherson et al. (2014, p.357) claim that 'the potential for a manufacturing revival lies in the networks of small producers and regional governance, building a shared interest and embedding firms in regions'. For example, in northern England, Tomlinson and Branston (2014) demonstrated this industrial ceramics region avoided decline by exploiting its traditional strengths. Firms adopted new strategies, technologies, developed existing relationships that strengthened new collaborations and networks, subsequently reinvigorating local production and innovation. Tomlinson and Branston (2014) insist, that decline in old industrial regions

is not inevitable and through adaptation, strategic transition approaches and leveraging regional strengths, new trajectories are possible.

A third geographical contribution is the role of social regulation and institutions within regional space, place and scale. Through an economic geography lens, Hansen and Coenen (2015) emphasise the role of variation in institutional foundations in different geographical arenas, and thus different in economic activity and performance. Markey et al. (2001) indicates that relationships and networks binding spatial scale can be explained within the institutional landscape of a region. This landscape constitutes institutions such as, industry bodies, trade unions, business chambers, regional development agencies and forms of social regulation including, ideas, norms, culture, rules, government activity and production infrastructure. Coenen and Truffer (2012) introduce these elements as ‘institutional thickness’ and an indicator of regional leadership in innovative performance. Successful regional attributes of thickening highlight institutional presence and partnerships built on innovation, trust, effective structures and a progressive sense of place (Amin and Thrift 1994). However, many regions in Australia, have relied on existing heavy engineering, steel and coal production industries as significant employers, generating little diversity for new path creation. This has engendered industrial regions ‘locked in’ to past specialisations which are slow to adapt to change (Tomlinson and Branston 2014). Pearce and Stilwell (2008) observe that institutional networks are critical in building capacity to implement effective policies in transitioning region practice. Comparing Australia with Sweden, they argue that Australia has lacked Sweden’s tradition of systematic ‘interventionist’ industry and labour retraining policies that enable regions to explore alternative paths distinguishing them from other geographies on a national and international scale.

The final spatial attribute, which proposes that regulation and institutional theory are linked with the history of a region (MacKinnon 2001), derives from an evolutionary economic geography perspective (Hansen and Coenen 2015). Hansen and Coenen (2015) demonstrate how geography matters in determining the evolutionary trajectory of a system, and thus understanding historical path-dependencies and characteristics, such as organisational routines, is important. Similarly, Markey et al. (2001) advocate the importance of understanding regional identity as shaped by changing production relationships and the history of a particular location, making it fluid and not fixed. If a local economy

can be analysed as the historical product of layers of activity, those layers represent cultural, political and ideological elements as well as economic, contributing to the role they play within broader national and global spatial structures (Massey 1995). In a similar vein, Benneworth (2004) explores the importance of location as anchorage to explain tradition in regions, enabling entrepreneurs to embed new firms and ideas with traditions of the old.

Viewing the manufacturing transition through a spatial lens presents the third element of the Attributes of a Sustainable Transition conceptual framework and complements the elements presented within advanced manufacturing and sustainable transition theory. This approach deepens the analysis, pinpointing characteristics and elements of transitions that differentiate one region from another. As Hansen and Coenen (2015, p.6) suggest, ‘transitions are constituted spatially and unpacking this configuration will allow us to better understand the underlying processes that give rise to these patterns. This requires analysis of particular settings (places) in which transitions are embedded and evolve, whilst at the same time, paying attention to the geographical connections and interactions within and between that place and others’. Hence, whilst Table 3.3 illustrates similarities across the three approaches, a spatial lens enables the manufacturing transition to be analysed in the context of place, scale, levels and within interconnections of relationships.

The coexistence of economic and environmental challenges opens up both the possibility and necessity for alternative approaches. Indeed, the importance of linking regional and local with current manufacturing sector challenges and industrial path-dependence policies to achieve sustainable economic alternative solutions, is gaining particular urgency. Shove and Walker (2007) highlighted the importance of the local political context, knowledge and skills of local transition managers and stakeholders for the transition process and the possibility of these contextual factors varying by geographical settings, stressing the importance of place-specificity for sustainability transitions. The next section explores these elements within a Transition Regions approach.

Table 3.3: Comparison - Attributes of regions in a spatial context (Massey 1995; Markey et al. 2001; Geels 2002; Gibbs and O'Neill 2014)

<b>Advanced Manufacturing &amp; Sustainable Transition theory (Similarities)</b>	<b>Regions are Spatial (Additional elements)</b>
Socio-Technical System approach	Spatial context – not fixed but fluid
Understanding beliefs, cultural/social norms, and behaviours	Spatial relationships between actors/institutions
Institutional form (regulatory and cultural)	Institutional thickness – trust, culture of sharing, sense of openness
Governance	Understanding narrative of place, Shaping identity, Past creates pathway to present, sense of place
Political appreciation	A moment in network of social and cultural relations
Internal/external focus	Sub-national/regional and local scales
Innovation	Changing relations between levels/scales
Collaboration	

### 3.6 Transition Regions

The final element of the Attributes of a Sustainable Transition theoretical framework rethinks the advanced manufacturing, sustainable transition and spatiality of regions concept alongside the concept of Transition Regions (Enright and Roberts 2001; Cooke 2009; Horwitch and Mulloth 2010; Amison and Bailey 2014 and Gibbs and O'Neill, 2014). Whilst transition regions belongs in the field of Evolutionary Economic Geography, Cooke (2009) defines its importance as a critical green regional economic development platform. This regional platform constitutes sub-national administrative areas, mechanisms to support green industries, clusters of related sustainable activity and a program of related variety actors and sub-sectors. In this way, Cooke (2009) positions actors within transition regions at the forefront of transition-friendly innovation for sustainability (Cooke 2010). To elaborate, Cooke (2009) presents three notions validating the significance of the transition regions platform, in facilitating transition research and the role of manufacturing in industrial transformation: path-dependence, related variety and proximity.

### **3.6.1 Path-dependence**

First, an understanding of ‘path-dependence’ is required to comprehend blockages hindering regeneration of the traditional manufacturing sector and development of new sustainable pathways. Greco and Di Fabbio (2014, p.413) describe path-dependence as ‘fed by specific “lock-in” mechanisms that emerge when patterns of activity form a groove, and prevent a system from deviating from the initial conditions’. In other words, manufacturing regions can be overspecialised in mature technologies and heavily invested in production facilities. As a result, they become locked-in to a particular pathway until a new stimulant disrupts this path. Australian traditional manufacturing for example, is often criticised for following mature technological trajectories that lack innovation and instead focus on process optimisation and efficiencies. Efforts to introduce radically new products into the market tend to be led by entrepreneurial start-up companies. As regions are shaped by relations, institutions and history, the basic mechanisms of path-dependence, can also be place-dependent (Cooke 2009) and, as Hansen and Coenen (2015) therefore illustrate, niches do not just emerge, but are marked by distinct regional path-dependencies.

### **3.6.2 Related Variety**

Second, ‘related variety’ characteristics, such as shared activities and competences, stimulate ‘knowledge spillover’ between firms located near one another, encouraging potential for regional diversification and learning in new growth sectors. Although there is little literature and empirical evidence on the role of related variety in facilitating regional manufacturing renewal, Amison and Bailey (2014) have highlighted the importance of shifting from specialisation towards diversification of regional manufacturing structures through the recombination of different but related local knowledge, skills and competences.

Amison and Bailey (2014) compare the concept of related variety with that of the Phoenix Industry model. Phoenix industries are clusters of small-medium enterprises working with broadly similar technologies that have emerged in former industrial areas. Within this model, the process of innovation has become increasingly open, shifting from taking place within a single firm to taking place across firm boundaries. Seven key attributes of this model include, the presence of supplier firms and relevant skills in the local labour force, technical skills and expertise in nearby higher education institutes,

universities and other training or research facilities, personal networks, market knowledge, capital for investment and reputational factors. The regions of Pittsburgh, USA and Shenyang, China, which effectively reinvented their old steel and metalworking industries, are examples of related variety cases (Svensson, Klofsten and Etzkowitz 2012). By infusing industries with new technological research capability and local skills from previous related sectors, Pittsburgh, created niche opportunities and path breaking products in medical devices and Shenyang in software manufacturing.

### **3.6.3 Proximity**

Third, ‘proximity’ within and external to the region involves understanding how relational and physical dimensions facilitate knowledge transfer among entrepreneurs and managers in related industries. Transition regions suggests that a proximity of actors generates clusters, that can drive change in path-dependent regimes by promoting, institutional thickness, building trust and grounding socio-technical transitions in geographic space, particularly in manufacturing districts. In Australia, this form of cluster development is weak (Enright and Roberts 2001). For example, a National Economics Study found that, eleven regional manufacturers were deficient in knowledge networks and failure to develop collaborations was undermining the region’s competitiveness. When questioned about collaboration, respondents were sceptical, highlighting a reluctance to share information, a lack of trust and a ‘what’s in it for me’ attitude (Committee for Economic Development Australia and Regional Development Victoria 2013). Nevertheless, in other parts of the world, examples of strong proximity initiatives are emerging. For Horwitch and Mulloth (2010), the emergence of ‘clean technology’ clusters in New York, is one example. Rather than viewed through the lens of distinct sectors, clusters of firms are blended, networked and boundary spanning and engaged in social entrepreneurship and grassroots initiatives. In Boston, Massachusetts, McCauley and Stephens (2012) found that clustering activities in a green economy, displayed attributes of strong alliances, institutional support, technology development, venture capital investment and university engagement in addition to ensuring alignment of environmental and economic development policies. Returning to the region of Pittsburgh, although it exhausted its steelmaking capacity, it did not lose its steel making expertise. Pittsburgh utilised its strengths of proximate location, industrial legacy and labour expertise to transition from a steel making town to a steel technology cluster. Figure 3.6 draws on the work of Enright and Roberts (2001), Cooke

(2009), Horwitch and Mulloth (2010), Amison and Bailey (2014) and Gibbs and O'Neill (2014) to conceptualise the attributes of a transition regions approach.

Cooke (2009) cites other cases from the Danish wind industry, where experimentation, knowledge spillover and niche market evolution within the agricultural and marine engineering sectors, enabled transformation of the plough and a ships propeller into wind aligned technology. The transition of the automotive and steel manufacturing towns of Muncie and Akron in the USA are two other examples (Tumber 2011). In 2000, in recognition of the substantial regional wind corridors and gear box manufacturing capability within the existing automotive industry, Brevini Wind relocated their head office to Muncie, which led to the formation of a business cluster for wind focused renewable energy.

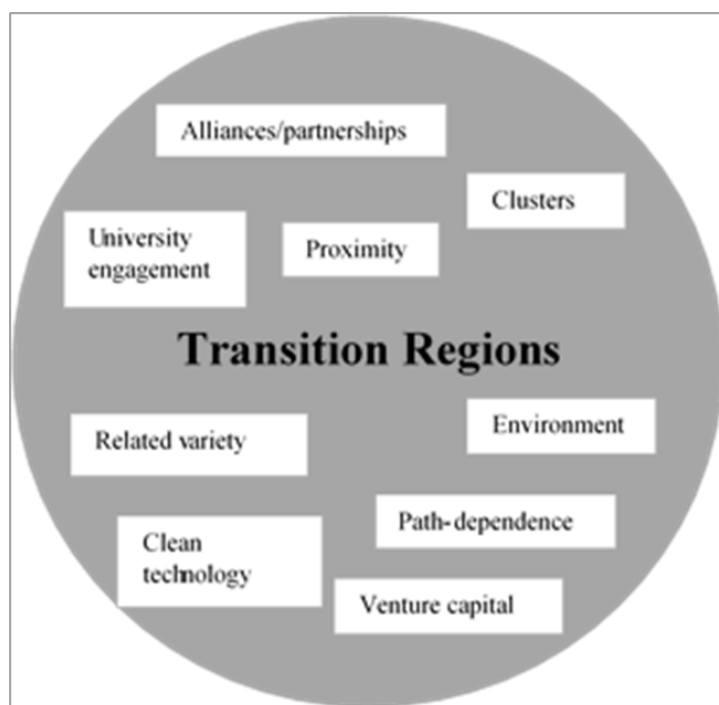


Figure 3.6: Attributes of Transition Regions (Enright and Roberts 2001; Cooke 2009; Horwitch and Mulloth 2010; Amison and Bailey 2014 and Gibbs and O'Neill 2014)

Muncie now produces large scale wind turbine gear boxes. Additionally, firms in Akron, home to Goodyear and Firestone tyre producers, embraced their experience in rubber materials manufacturing to become a research and production centre for polymer manufacturing. The region now produces domestic renewable energy products within the solar and wind industry sectors. These examples indicate the attributes of a transition regions platform, where Hansen and Coenen (2015) suggest regional actors have leverage to act, by mapping and supporting such clean technology clusters. In the literature on regional innovation policy, Asheim, Smith and Oughton (2011) echo this suggestion,



arguing that regional actors are better positioned to design transition activities and policies than national agencies, due to their local knowledge and understanding of the region's idiosyncrasies. This literature argues that all regions are innovative, but innovation differs due to local industrial and technological specialisations.

However, Weller and O'Neill (2014), propose two competing viewpoints to Cooke's ideas when exploring manufacturing transformations in regions. On one hand, support of 'old economy' manufacturing specialisations inhibits the emergence of 'new economy' jobs in advanced manufacturing and, consequently, the decline of old specialisations becomes both necessary and desirable to free resource for change. On the other hand, new specialisations can emerge from the old, path-dependent process employing a related variety approach. Therefore, retaining current capacity and skills is crucial to the viability not only of manufacturing, but of as-yet-undefined activities that will rely on pre-existing knowledge and skills. The debate about whether Australia for example, should continue to 'make things' is caught between these competing viewpoints. The problem is that neither view has enough traction to drive policy change within Australia, leading to a fragmented policy response (Weller and O'Neill 2014).

### **3.7. Conclusion**

This chapter provides a new conceptual approach that reviews and integrates interdisciplinary approaches to identify the existing and emerging attributes of a traditional, regional manufacturing sector's fundamental shift towards a sustainable economy. Whilst pursuit of a sustainable economy poses challenges, it also affords opportunities to create a new trajectory with the potential to stimulate alternative market prospects and competitive advantage for traditional manufacturing firms and associated regions. Climate change and increasing environmental pressures need to be addressed by new and innovative techniques that cannot be solved by 'business as usual' economic development strategies, nor can they be solved by singular models or narrowly focused strategies. Yet, existing one-dimensional orthodox, technologically focused approaches continue to maintain current path-dependence and decline in existing manufacturing industries and the regional communities that surround and depend upon them. There remains limited evidence on the factors which underpin

successful transitions, how to coordinate transitions and how to capture the opportunities for regeneration that climate change brings to the manufacturing sector.

Four bodies of literature have been reviewed to build the ‘Attributes of a Sustainable Transition’ conceptual framework including Advanced Manufacturing, Sustainable Transitions, Regions are Spatial and Transition Regions. In providing a framework that can be applied practically in a policy context and to guide future regional transitions, the approach addresses the science-practice gap. Figure 3.7 depicts the four conceptual approaches and associated attributes. When singularly applied, these models are limited in scope and focus, but when combined, facilitate a holistic exploration of the collective and emerging attributes of a sustainable transition. The framework is being used to guide empirical research on Australian case studies in 2016 – 2017 in Chapters 4-6. Hence, building this conceptual structure is the first stage in a bigger empirical project which, in examining the incidence, influence and interactions of the attributes identified, will also test the robustness of the framework. For example, the advanced manufacturing approach reconfigures a traditional industrial lens that focuses on high volume, low cost and physical production to consider non-technological attributes such as higher value add, customisation, innovative skill sets, collaborative and knowledge bound networks. However, advanced manufacturing is deficient in exploring the core values of sustainability and responsiveness within a spatial context. The sustainable transition approach extends the advanced manufacturing model, enabling recognition of manufacturing within the bigger picture of sustainable governance, technology and practice and presenting business and product diversification prospects. Yet, the sustainable transition approach has limited application where manufacturing firms are predominantly concentrated within regional areas. As a result, a spatial approach is also critical to the Attributes of a Sustainable Transition conceptual framework, to ensure an understanding of the geographic and scale characteristics distinguishing regions. A range of complex and diverse relationships, networks, institutions, narratives and cultural identities shape a particular manufacturing territory within its regional context. This is particularly relevant in the case of Australia where geographic size, socio-cultural settings and macro-economic challenges are different to most European industrialised countries. Equally, more research is needed in other geographical contexts to test the robustness of such a framework. Finally, a transition regions approach complements the framework, enabling recognition of the path-dependent, related variety and proximity attributes of a manufacturing

region. Within this model, a focus on knowledge, capabilities, competencies, expertise, place narrative and connections help recreate resilient industries that focus on building existing strengths to contribute to a global sustainable economic future.

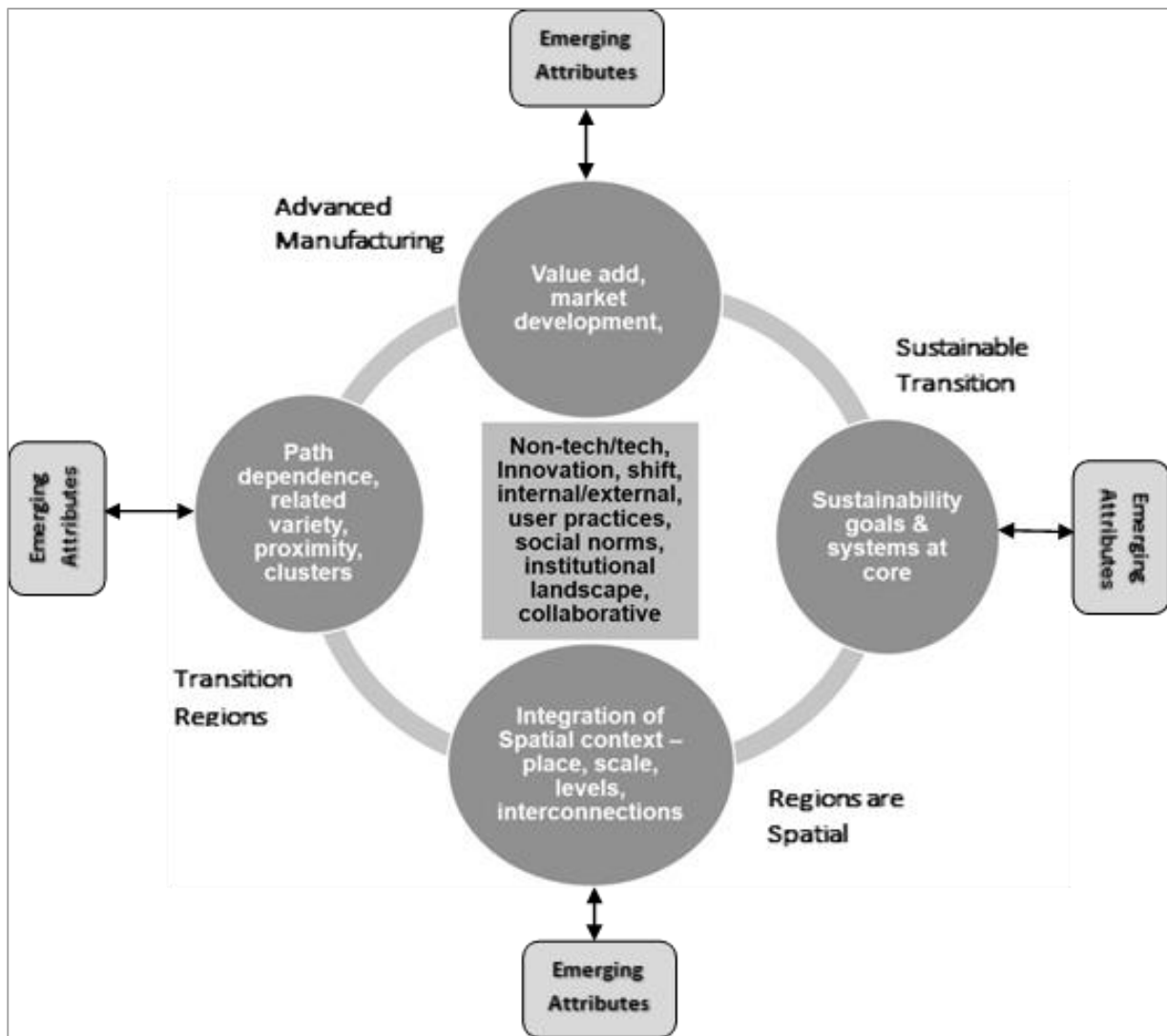


Figure 3.7: Attributes of a Sustainable Transition conceptual framework

Following this literary review of all major concepts to be considered for integration in the development of a new transitioning model, the next chapter goes on to consider two concepts of the theoretical model in more empirical detail.

## Chapter 4

### **Insights into a sustainable transition of the traditional manufacturing firm and industry sector in Australia**

This chapter specifically explores the advanced manufacturing and sustainable transition concepts within a global and Australian context, to establish the theoretical framework for subsequent analysis (see Chapter 3 for a detailed literature review analysing these concepts). A synopsis of the methodology is provided in section 4.3 (see Chapter 2 for a detailed overview of the methodological approach); empirical findings are presented in section 4.4 and the conceptual implications considered in section 4.5, before presenting a final conclusion in section 4.6.

The text below has been prepared for submission to the *Australian Journal of Management* – the Abstract is included in Appendix H. References are incorporated in the combined thesis list and additional comments linking this with the next chapter are included at the end.

#### **4.1. Introduction**

In many developed countries, traditional manufacturing has been confronted by a number of challenges and opportunities spurring a period of transition (Milne 2010). The impact of climate change and limiting finite resources, together with globalisation and technological advances, have required the manufacturing sector to adapt systems and outputs in new innovative ways. Efforts to reshape industries towards achieving a lower carbon and sustainable economy, within current economic frameworks, however, often lack the foresight needed to enable a successful transition (Bos, Brown and Farrelly 2014). In Australia, as in many other countries, manufacturing firms in the traditional construction, chemical, heavy engineering, machining and metals industries are acknowledging the need to transition towards higher value, innovative and sustainable operations. Thus far, studies on industry sustainable transitions have largely involved firms in European settings where geographically-specific political and institutional factors facilitate change. To build understanding more broadly of the dynamics of sustainable transitions and to examine alternative country contexts, this chapter draws on data from 24 Australian traditional manufacturing firms to

identify the socio-technical system characteristics for transformational change.

A sustainable transition involves ‘a change (in co-dynamics of technologies, institutions, organisations, social and economic structures) of systems (criteria to assess products, services and structures) towards environmental and social sustainable alternatives’ (Geels 2011, p.25). Currently, there remains little empirical evidence or explicit theoretical input on how these elements have contributed towards systematic transitions in the manufacturing sector. For example, Novotny and Laestadius’s (2014) analysis of companies that employed technological innovation to replace textiles derived from fossil based oils with cellulose products, did not consider whether organisational capability and business model innovation contributed to firm change. Similarly, Tumber (2011) illustrated the importance of collaboration and knowledge spillover in the transition of steel and automotive firms to ‘green’ manufacturing, but omitted to investigate whether broader technological, cultural and social attributes were also factors affecting change. However, considering these broader systems features is essential to understanding and informing the transition process, because the constraints they pose stem from interests that are solidified into institutions both at firm level (embodied in policies, standards, cultures, practices and behaviour) and at system level (socio-technical regimes).

Consequently, several interdisciplinary scholars have called for a re-conceptualisation of how manufacturing stimulates sustainable transitions. Jovane and Westkämper (2009) for instance, propose that coupling sustainability with economic efficiency reduces the intensity of materials use and energy consumption as well as improving the value of products to society and the organisation. Qian (2014) argues that sustainable manufacturing presents resource savings through production efficiencies, ecologically sensitive design and cleaner production, leading to fresh opportunities along the value chain. Markard, Geels and Loorbach (2010) suggest transition scholars could explore the role of manufacturing firms in influencing the development of sustainable transition policy (Organisation for Economic Co-operation and Development 2011; United Nations Environment Program 2014b; The Climate Institute 2015).

In Australia, the prospects for a traditional manufacturing shift towards a lower carbon economy, have been in constant turmoil in recent years due to a range of institutional and regime impediments.

For example, Australia's commitment to resource extraction has overlooked investment in future models of manufacturing activity, immobilising the voice of progressive innovative, advanced manufacturing firms in favour of 'short-term' commodity growth markets (Weller and O'Neill 2014). Roos (2016) emphasises the urgent need to shift Australia's current low cost and repetitive production patterns to those that yield higher value, advanced skills and global niche solutions. In response, Australian firms have begun to employ technological innovation strategies to improve efficiencies and enter new markets. Although this approach resonates with the Australian political, industrial and institutional landscape in addressing part of the need for change, it also restricts possibilities for holistic systems and nuanced repositioning of the manufacturing sector.

By drawing together the notions of advanced manufacturing, transition studies literature and wider industry empirical research, this chapter aims to address these restrictions. Using Australian firms as heuristic case studies, sustainable transitions theory is refined in relation to the socio-technical setting of manufacturing. Despite a few previous attempts, it is argued that a comprehensive theoretical framework exploring traditional manufacturing transition is still underdeveloped. Focusing on the socio-technical context, the primary aim is to identify the attributes of a sustainable transition in 24 traditional manufacturing firms. There is particular emphasis on the contribution individual firms make to positioning manufacturing within a lower carbon society, and to ascertain if an aggregation of sustainable manufacturing firms can influence system trends at a broader level.

## **4.2. Transitioning the traditional manufacturing sector – a theoretical framework**

During the last few decades, the market share of traditional manufacturing activity in many advanced countries has drastically declined and the services sector has grown. Increased costs in capital and labour, high exchange rates and global trade inequality, have led to the relocation of manufacturing off-shore and the closure of older or original manufacturing plants. At the same time, industry economy scholars such as Van Winden et al. (2010) argue that mass production or routinised activities are disappearing and being replaced with more advanced manufacturing techniques, raising new and increasing complexities for existing traditional manufacturing firms.

In Australia for example, manufacturing historically made a vital contribution to economic development. However, in recent decades it has been in relative decline (see section 1.2 and 3.3 for a full account of the weakening of Australia's manufacturing sector). Milne (2010) suggests that between the 1950s and 1980s, manufacturing accounted for up to 29.0 per cent of Australian Gross Domestic Product (GDP), but by 2011 this contribution had fallen to 6.8 per cent. Factors contributing to this deterioration include, low productivity growth, globalisation, a lack of innovation and more recently a reliance on resource extraction (Green and Roos 2012). While much of the economic literature argues external forces triggered this decline, internal firm strategies and behaviours have also had an impact. For instance, Roos et al. (2014) propose that Australian manufacturing's high volume, low value production culture has influenced its low standing on the Economic Complexity Index (ECI); Australia is positioned at number 79. Rather, it is attributes such as sophisticated, high value and niche production that increase a country's ECI. Building such a value chain philosophy has evaded traditional manufacturing firms in the sectors of construction, chemicals, heavy engineering, machining and metals which seek a competitive edge in a global value and business innovation network.

Firmly embedded within global production and industry studies literature, advanced manufacturing concepts (see section 3.4) embrace non-technological as well as technological innovation and are currently being employed to reposition the traditional manufacturer for the future (Roos et al. 2014). For instance, Shipp et al. (2012) describe how manufacturing is evolving from a more labour intensive set of mechanical activities (traditional manufacturing) to a sophisticated set of informed-technology-based processes influenced by six large scale trends:

- Globalisation of manufacturing networks and value chains,
- Ubiquitous roles of information technology,
- Growing reliance on modelling and simulation in the manufacturing process,
- Acceleration of innovation in global supply chain management,
- Rapid changeability in response to customer needs and external impediments, and
- Acceptance and support of sustainable manufacturing.

Shipp et al. (2012) argue that the growth of advanced manufacturing within particular countries depends on enabling factors that domestic governments can influence, such as infrastructure quality, skills development and a stable business environment, as well as factors that they cannot control, such as private sector market activity. As the digital and physical world of manufacturing converge, it is these enabling factors that have become ever more essential to company-and-country-level competitiveness. Thus, rather than manufacturers concentrating on the ‘making of things’, an advanced manufacturing model encompasses the whole chain of activity from research and development to end-of-life management, which is ‘well beyond what happens on the factory floor’ (Stevens 2015).

Chapter 3 described the characteristics of a shift towards an advanced manufacturing model (see section 3.4). Non-technological attributes such as business innovation, higher value skill sets and collaboration are illustrated, which are absent in traditional manufacturing models. Green and Roos (2012) argue that combining these elements with the stand-alone physical fabrication process in German and Swedish medium-technology manufacturing, increased output and efficiency by 29.0 per cent. This evidence suggests that a potential factor contributing to Australia’s low productivity and innovative growth may be its comparatively low investment in developing non-technological attributes.

However, whilst the advanced manufacturing concept promotes high value thinking and innovation for future manufacturing, it places lesser emphasis on identifying the attributes for a sustainable transition. For instance, while Shipp et al. (2012) strive to build acceptance and support for sustainable manufacturing, they do so by placing priority on the environment without the need for the manufacturer to increase costs or sacrifice performance. Australian industry, institutional and political actors are struggling to digest such an objective. Policy and funding initiatives tend to promote technological fixes that tackle resource efficiency and lean manufacturing targets, but do little to affect systematic cultural and philosophical change (Schot 2016). Loorbach and Wijsman (2013) claim that as a result, current advanced manufacturing approaches largely help maintain the existing regime of production. As Geels (2011, p.25) observes, this transformation requires ‘a change of systems towards environmental and social sustainable alternatives.’ Therefore, a key



limitation of the advanced manufacturing conceptual approach, is that it fails to capture how the need for profit and creation of jobs can be balanced with a greater understanding and application of sustainable values. As a consequence, whilst advanced manufacturing attempts to shift the manufacturing regime to a more advanced innovative state, for a sustainable reorientation the model does not go far enough.

#### **4.2.1 Towards a sustainable ‘manufacturing’ economy**

There is a broad literature focusing on sustainability and business seeking to understand how creating economic value could also limit ecological impact and increase social responsibility (Loorbach and Wijsman 2013) (see section 3.1). Yet, much of this literature centres on incremental and singular approaches of technological and market driven change and neglects to address practical strategies required by society, business and individual firms to translate concepts of sustainability into reality. Critiquing these contributions for their technological, top down focus, scholars have argued for more integrated thinking that incorporates the social, institutional and spatial dimensions (George, McGahan and Prabhu 2012) needed to facilitate a sustainable transition.

In response, a socio-technical system framework has emerged over the last decade, formed by the intersection of evolutionary economics (Nelson and Winter 2009), institutional theory (Scott 1987) and science and technology studies (Rip and Kemp 1998; Trist 1981; Geels 2002; Geels and Schot 2007; Loorbach and Rotmans 2010). Combined, these contributions explore major changes in societal cultures, structures and practices that occur as a result of the co-evolution between economy, society and ecology (Loorbach and Rotmans 2010) and can be viewed as a shift from one position to another. This chapter studies these changes in search of sustainable manufacturing alternatives that create economic value for the firm. Such a shift also reduces the ecological impact of manufacturing activity, increases a firm’s social responsibility and reorients its institutional and cultural dynamics within a socio-technical system approach.

Although some industrial economics and geography scholars have begun to explore these features through a sustainable transition lens (Cooke 2013; Loorbach and Wijsman 2013; Coenen, Moodysson and Martin 2014), these studies have been mainly based in European settings, among

firms which have maintained long-standing commitments to adopting sustainability initiatives. This chapter extends this body of research to include the Australian manufacturing context, in the process highlighting new transition elements based on political and institutional differences. To explore sustainable transition patterns in a manufacturing setting, this study envisages the transition process within the multi-level perspective (Geels 2002) and transition management dimension (Rotmans, Kemp and Asselt 2001; Skellern, Markey and Thornthwaite 2017).

#### 4.2.1.1 Multi-Level Perspective

The multi-level perspective introduced in detail in Chapter 3, is adapted in Figure 4.1(a), as a heuristic framework that guides the analyst to investigate relevant issues associated with the history, drivers, barriers and opportunities of manufacturing transition pathways across three analytical levels: macro (external trends and pressures), meso (internal regime) and micro (niche-innovations) (Rip and Kemp 1998; Geels 2002).

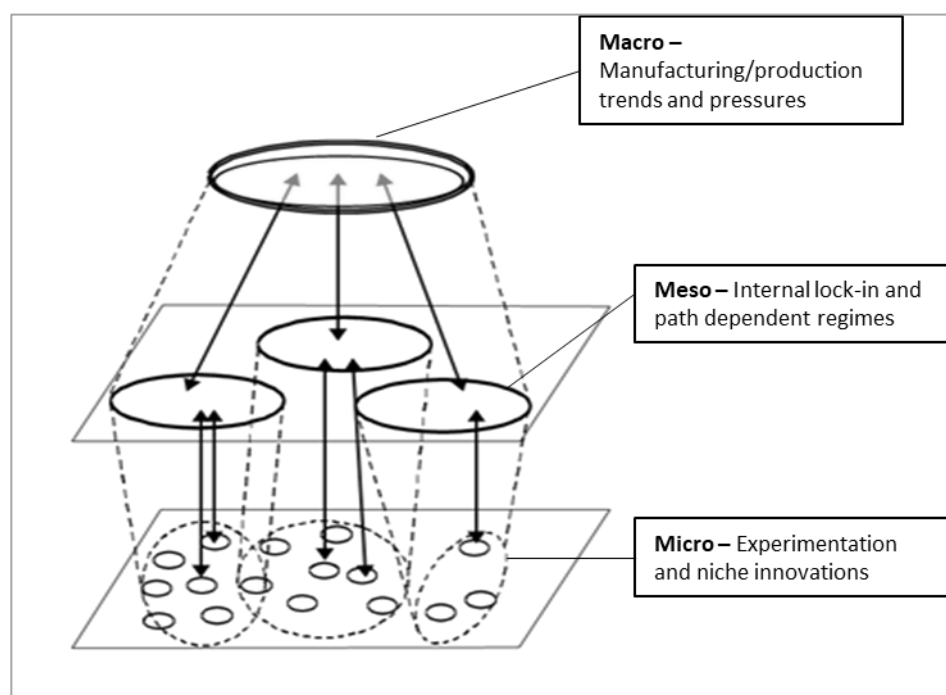


Figure 4.1(a): Multi-level model of transition (Rip and Kemp 1998; Geels 2002)

The macro level depicted in Figure 4.1(a), explores manufacturing pressures and trends across the global, political, institutional and technological spheres that impact the existing regime. The meso level examines interactions between socio-technical barriers and path-dependent regimes that shape the

current system and resist change, maintaining the status quo. The micro level refers to factors which influence innovative activity, towards destabilising the regime and new path creation (Berkhout et al. 2010).

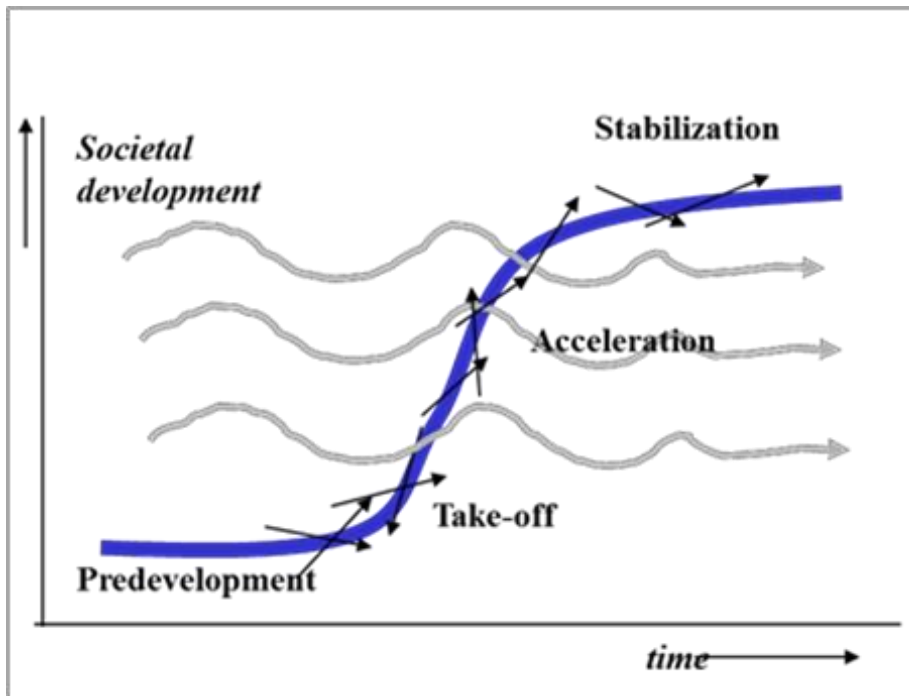


Figure 4.1(b): Multi-phase model of transition (Rotmans, Kemp and Asselt 2001; Loorbach and Rotmans 2010)

Existing systems are distinguished by stability and lock-in which deliver incremental change, but emerging niche alternatives drive radical change altering the existing regime. Such a rapid shift in mind-set and product diversification is unfamiliar, and alien to current practices or operations, thus firms often struggle to accept such change. As a result, the multi-phases of transition depicted in Figure 4.1(b) illustrate a very long predevelopment phase of build-up for these organisations before moving towards the other three phases (Loorbach and Rotmans 2010). A second multi-phase typology exists, which in comparison to the latter model, presents three basic pathways through which existing regimes can change: stability (pre-development), dynamic (take-off - acceleration) and transformation (stabilisation) (Boons 2009). The multi-level perspective investigates these dynamic pathways and how the interactions are played out across the different levels (Geels 2011). It analyses current business strategies for innovation and sustainability, which either increase agility and transformative capacity of the firm or enhance lock-in and optimise the status quo. Yet, to date a socio-

technical analysis of the traditional manufacturing sector in Australia has not been conducted.

#### 4.2.1.2 Transition Management (TM)

Transition Management is a second heuristic frame that is designed to steer practices towards a transition (Loorbach and Wijsman 2013) (see section 3.4). Figure 4.2 illustrates how this prescriptive governance framework aims to coordinate sustainable transition pathways through four interchangeable phases (Loorbach 2010): strategic, tactical, operational and reflexive.

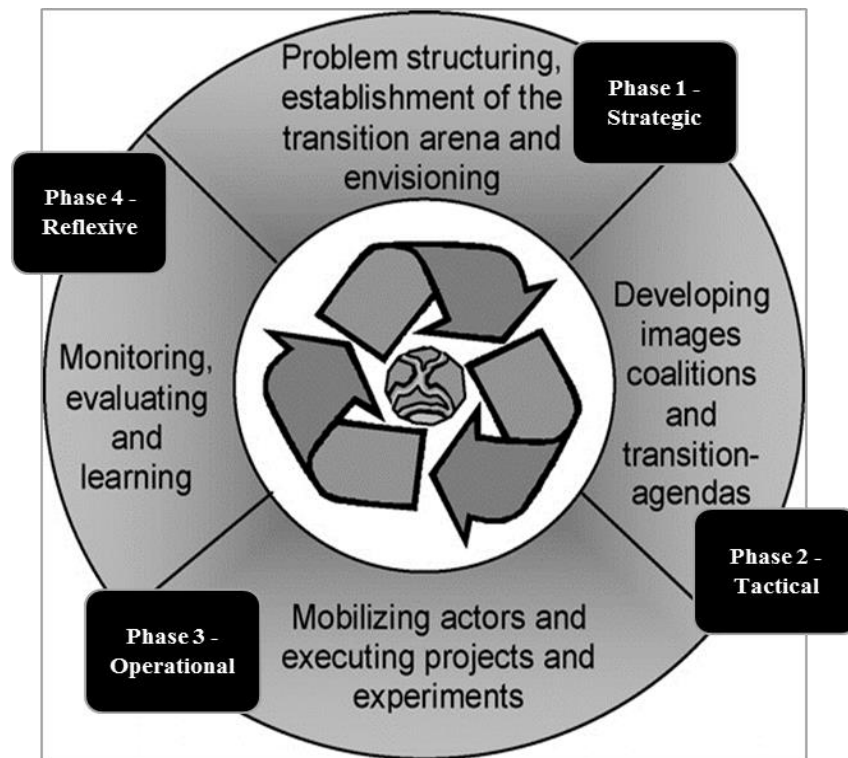


Figure 4.2: Transition Management (Loorbach 2010)

The strategic phase involves designing the transition vision, priorities and arena by first exploring the problem. The second step develops the agenda and collaborative networks as part of the tactical phase, whilst the operational phase facilitates the establishment of a physical structure for the sustainable system by mobilising actors and experimental strategies. Measuring sustainability performance throughout the transition journey is advocated in the reflexive stage (Loorbach 2010). A case study employing the transition management framework across the roofing sector in the Netherlands is shown in Figure 4.3, with the three phases of the transition management framework (strategic, tactical and operational) marked.

A sustainable transition has enabled the roofing sector to explore alternative institutional and organisational processes and practices by combining economic profitability, social responsibility and environmental sustainability in fundamentally new ways.

The roof-transition project was initiated by the ESHA Group, a producer of bituminous products in the Netherlands. The project aim was to identify potential pathways which the sector could create value by means of product innovation and partnerships. The process started with a study framing the challenge within the transition context, this stimulated discussion with frontrunners across the sector to develop a joint transition agenda and vision (strategic phase). Participants were selected on their relevance based on the system analysis conducted and the diversity of the roofing sector across the chain and those concerned with sustainability (tactical phase). Within this transition arena, actors debated the innovative reframing of roofs focused on broader sustainability involving different platforms, new rules, design, technologies and practices (operational phase). ESHA opened the first 100 per cent bitumen-recycling plant in 2008 and develops sustainable roofing equipment. There now is a sector wide attention to sustainable roofs, local sustainable roof programs, new companies have been established and new professions have emerged (roof gardeners). All of these initiatives are linked to persistent societal problems in the Netherlands (such as water problems, energy dependency and safety issues in public buildings) and geared towards fundamentally changing 'business as usual'. By entering a cross sector process based on a shared transition, new roles and practices are being defined and experimented with, thereby trying to break away from existing routines. The 'roof-transition' has been adopted by national policy as one of the central innovation programs for the built environment.

Figure 4.3: An example of the transition management approach initiated by the ESHA Group, in the Netherlands (adapted from Loorbach and Wijsman 2013, p.25)

This study combines the advanced manufacturing and sustainable transition concepts (see Figure 4.4), which can contribute to the systematic analysis of the socio-technical setting and sustainable transition attributes of a manufacturing firm.

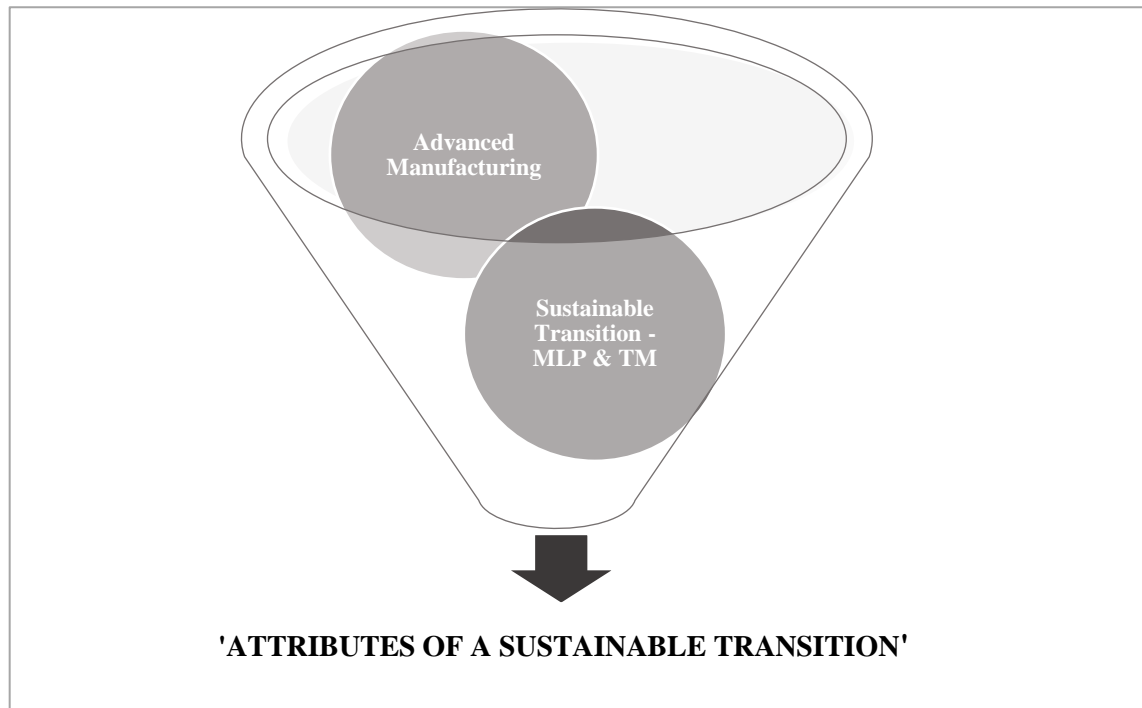


Figure 4.4: Attributes of a Sustainable Transition

### 4.3. Research approach and methodology

Two parts of the Attributes of a Sustainable Transition conceptual framework – advanced manufacturing and sustainable transition studies (see section 4.2 and Figure 4.4), are combined to explore transition attributes within an Australian traditional manufacturing context. So a cross-case study and qualitative fieldwork approach have been employed to gather data from 24 traditional manufacturing firms. Whilst Chapter 2 provides a thorough overview of the research methodology employed in these studies, a synopsis is provided here to position the empirical findings in their methodological setting. For instance, the multi-phase transition approach (Loorbach and Rotmans 2010) was modified using elements from the strategic transition perspective (Boons 2009). Whilst the multi-phase approach captures the predevelopment, take-off, acceleration and stabilisation stages of a transition, the strategic perspective portrays a transition as either stable, dynamic or transformative. Both models illustrate contradictions across similar dimensions. For instance, Loorbach and Rotmans (2010) suggest ‘stabilisation’ occurs when system innovation principles are fully implemented, whereas, Boons (2009) proposes ‘stability’ is attributed to business as usual and lock-in to a specified technological trajectory.

By employing advanced manufacturing and sustainable transition concepts, a complementary typology is adopted to ascertain the stage of transition appropriate to each manufacturing context. Figure 4.5 presents an adaptation of the two aforementioned typologies across five alternate phases: Maintain Status Quo, Resource Efficiency and Product Stewardship, Tipping Point, Reconfiguration and System Innovation. Adopting within and cross-case analysis then enabled the identification of key patterns and themes of transition across the case studies.

Manufacturing firms were selected and recruited in consultation with local industry representatives in each region and selected based on their level of product and process innovation spanning the previous five to ten years (see section 2.3). A semi-structured interview of one to two hours was conducted with the general manager of each firm on site. This approach enabled first-hand information to be gathered regarding individual firm transition and business development strategies, skills and capabilities, barriers to change, existing and potential collaborations and other key attributes. All interviews were audio-taped, transcribed verbatim and coded using qualitative data analysis software, NVivo.

Whilst the application of advanced manufacturing and sustainable transition thinking at a manufacturing firm and industry scale is analysed here, it does not indicate whether the Attributes of a Sustainable Transition theoretical framework has been successful in identifying factors driving the change process or if the findings are representative of broader manufacturing system level trends. However, as one of only a handful of studies in manufacturing sustainable transitions (Loorbach and Wijsman 2013), the analysis demonstrates the application potential if the framework were aggregated across a number of manufacturing industries and regions.

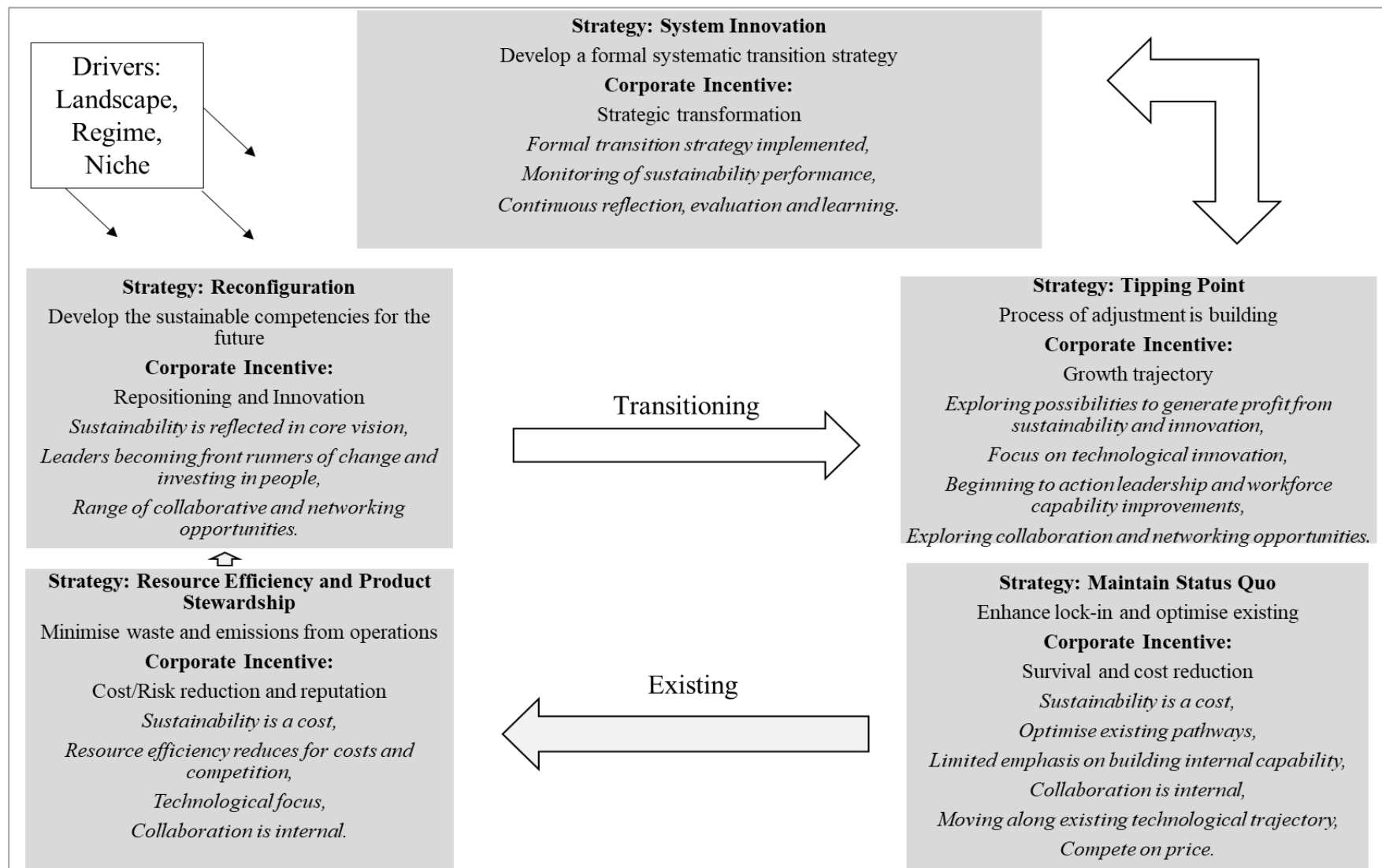


Figure 4.5: Sustainable Transition Perspectives for Case Study Firms (adapted from Hart and Milstein 2003)



## 4.4 Traditional manufacturing – attributes of a sustainable transition

This section applies the analytical framework presented above to identify the socio-technical attributes of a sustainable transition within 24 traditional manufacturing firms. The approach investigates three dynamic interactions impacting a firm's ability to change in response to landscape pressures, socio-technical regime factors and niche-innovations, summarised in Table 4.1. The subsequent analysis interprets these factors within the transition perspective for each case study firm.

Table 4.1: Multi-Level Perspective analysis of 24 case study manufacturing firms

<b>Landscape Pressure Factors (Macro)</b>	<b>Socio-Technical Regime Factors (Meso)</b>	<b>Niche-Innovation Factors (Micro)</b>
<p>(Destabilise)</p> <p>Constant policy change &amp; initiatives, growth of new technology &amp; digitalisation, low socio-economic skills base, media &amp; society perceptions of manufacturing, globalisation creates unlevel playing field, high Australian \$, Australia's small economy, energy prices, limited finance options, consumer culture of consumption, sustainable development pressures.</p> <p>(Stabilise)</p> <p>Policy initiatives, regulations &amp; standards favouring sustainability, acceptance of 'business case for sustainability', growth of service sector, technological development, information communication technology (ICT), knowledge growth, drive for increase skill levels, advanced materials and production techniques.</p>	<p>Firm is group owned (often multi-national), cutting costs and resource efficiency dominate, management lack transition &amp;/or future manufacturing capability or skills, staff lack transition &amp;/or relevant skill capability, perceptions of sustainability is 'greenwashing', culture of blame &amp; distrust, autocratic, business as usual production techniques, lack of collaboration, performance based on KPIs and price, complacency mind-set and culture, sunk technological investments, waiting for the customer to lead sustainability.</p>	<p>ICT for system integration &amp; communication, application of advanced (stronger, lighter, sustainable) materials, automated, advanced, collaborative production experiments &amp; techniques, increase in sustainable standards and initiatives, global networks, sustainable product development i.e. renewables, new manufacturing partnerships, open innovation business models, recruitment of new skills, renewal of internal team structures.</p>

Note: Each column summarises respondent comments for each category across the 24 case studies.

### 4.4.1. Landscape pressures

Table 4.1 suggests that all firms experienced destabilising and stabilising landscape pressures based on political, institutional and societal interventions, limitations in learning and market and economic drivers. While global climate change and sustainability goals drive momentum, successive national policy deviations cause confusion and reduce industry confidence. Simultaneously, much less policy

attention has been given to the strategic role sustainability could play for the manufacturing sector given the right enabling conditions, with government initiatives such as energy efficiency legislation and product disclosures simply serving to incentivise firms to drive incremental change. Additionally, Table 4.1 emphasises that increasing global competition has created inequalities for exporting firms which lack access to the subsidised land, wages and tax free concessions other countries adopt to stimulate locally-based manufacturing. Equally important are societal and media stereotypes of inefficient and outdated manufacturing processes that often overlook innovative champions. For example, while large corporate infrastructure projects attract media headlines, innovation in small to medium enterprises is interpreted as ‘un-newsworthy’. This prevents a more nuanced picture developing of a diverse and changing manufacturing sector.

A shortage of higher technological and advanced skills, knowledge and learning practices in firms also inhibits growth and innovation. For instance, the trend driving servitisation, customisation and value-adding activities for manufacturers, require complementing new capabilities with the old, yet firms often need to ‘buy-in’ expertise or seek specialised training to acquire the skills to carry out strategic repositioning. An increase in knowledge intensifies demand for information communication technology (ICT) and emerging technological development brings efficiencies and advances in production processes. Whilst such pressures allow resources and effort to focus on innovation and creativity rather than administration and bureaucracy, significant retooling and investment across the skills base of firms is required to keep abreast of change. With 75.0 per cent of study participant firms employing a workforce with a low-medium skill set, such capability building will prove to be a complex task for the traditional manufacturing firm.

In addition, market and economic landscape pressures such as fluctuating exchange rates, increasing energy prices and rising unit-labour costs make conditions difficult for the manufacturing sector. These factors have contributed to an increase in off-shore manufacturing practices, maintaining a mass production ethos rather than a focus on innovative problem solving. Hence, rather than attempting to address and change behaviours of consumption, a competition culture drives manufacturers to produce more of the same, diminishing the need or want to be sustainable.

#### 4.4.2. Socio-Technical Regime

Whilst an essential part of systems analysis involves understanding the destabilising and stabilising landscape pressures impacting manufacturing, examinations of internal lock-in and path-dependent factors are also important. These are represented as socio-technical regime factors in Table 4.1. All 24 firms demonstrated challenges in shifting the regime, but eight identified distinct socio-technical barriers inhibiting a shift towards a sustainable trajectory. The experience of these eight firms is depicted in the first column of Table 4.2. Columns two and three in turn refer to the ten firms at a tipping point and six firms undertaking reconfiguration.

Table 4.2: Transition attributes of 24 case study manufacturing firms

<b>Status Quo – Resource Efficiency</b> (Enhance lock-in and optimise existing operations) <b>8 firms</b>	<b>Tipping Point</b> (Process of adjustment is building) <b>10 firms</b>	<b>Reconfiguration</b> (Developing sustainable opportunities for the future) <b>6 firms</b>
Sustainability is a cost	Exploring possibilities to generate profit from sustainability and innovation	Sustainability is captured in core vision
Resources efficiency undertaken to save costs and increase market share	Focus on technological innovation	Development of sustainable product and process opportunities
Technological focus	Beginning to take action to improve leadership and workforce limitations	Leaders becoming front runners of change and investing in people
Collaboration is internal	Exploring collaboration and networking opportunities	Range of firm, extra-regional, institutional and global strategies employed
Limited emphasis on building internal capability		Collaboration, partnerships and knowledge sharing with a diversity of stakeholders
Compete on price		Building future skills and knowledge in sustainability and innovative manufacturing
Moving along technological trajectory		Business model driven by social, economic and environmental goals and a culture of experimentation

Of the eight firms which maintained the ‘Status Quo’, two were optimising existing strategies for sustainability and innovation. Although experiencing a buildup of pressure, internal actors were reluctant to instigate change, preferring to maintain a fixed technological trajectory and drive profit from it (Boons 2009). On the other hand, six of the eight firms focused on both technological solutions and optimisation of current operational models. These firms employed a ‘Resource Efficiency’ and product stewardship perspective, positioning sustainability to achieve resource efficient cost saving measures. When analysing characteristics of these firms, four of the eight firms, two operating in textile and two in heavy engineering, advocated the traditional manufacturing philosophy of volume and price over sustainability and innovation.

#### 4.4.2.1 Internalising Sustainability

Five of the eight firms in column one of Table 4.2 perceived sustainability as a cost, something that would be good to do for the environment, or to tick the 'green box' of a customer contract, rather than intrinsic to everyday business operations. These responses illustrated an absence of a business case for sustainability. For these firms, competition, underutilisation of factories and cost pressures are the main problems impacting business operations, with energy and lighting retrofits and recycling programs implemented as cost saving measures rather than complementary value added features. The firm regime feels compelled to take sustainable action only if it reduces costs, employing a 'have to' rather than a 'want to' mind-set. All eight firms in Table 4.2 sought to optimise existing production systems to meet the agenda of the parent company or multi-national group, rather than strategically positioning innovation and sustainability within core business. However, Tether (2002) advocates that 'group firms' are able to draw upon other resources of the parent company to facilitate profitable business activity, such as market knowledge and access to investment, hence the five firms in column one of Table 4.2 possess limited motivation to seek other opportunities for growth. Likewise, governance and organisational culture focused on increased profit, short-term investment, organisational efficiency and internal competition. These incumbent actors do not actively work towards a sustainable transition because climate change and sustainability are not a corporate priority.

A resource efficient approach engages shareholders in the 'value' conversation and provides managers with cost cutting and increased profit solutions (Hart and Milstein 2003). However, as Loorbach and Wijsman (2013) argue, applying a resource efficiency mind-set only pertains to the institutional, structural and cultural boundaries of the competitive market model and therefore, impedes any broader shift for sustainability change. Ehrenfeld (2005) claims this approach tends to focus on unsustainable firm-level behaviour and ultimately optimises existing business growth tactics over innovative practices. Consequently, the firm remains locked-in to a path trajectory of incremental change unable to shift to a more strategic sustainability position.

#### 4.4.2.2 Leadership and Workforce Capability

An associated challenge for firms internalising sustainability was the capacity to build upon current management and workforce capability, listed in Table 4.2. A cultural transformation of organisational leadership was considered necessary by several firms to stimulate a mind-set shift within the firm. A key cultural barrier preventing such a shift included traditional manufacturing styles, where management set the task and the factory floor responded. This was exacerbated in family owned firms where practices and norms were long established through successive domestic management strategies. For instance, 7W and 6W said:

*The company has been around for 39 years. My father started it...they are lucky enough to have three sons...we have done the same trade and all started on the shop floor...and then progressed into office type activities 7W.*

*Family run business for 40 years...I asked my uncle about doing my MBA and he said 'why'...you will learn from work and then go and do your MBA when a bit more mature...at 40 6W.*

According to Smith (2003), governance of family businesses consists of two social systems, the family and the firm, which although interwoven, frequently have conflicting visions of the firm's future management and direction. This can limit the emphasis on building future capability to address change. In some cases leaders in the firms studied, failed to grasp fully the extent or need for a transition. For instance, as one respondent said: *Historically, we have centred on the steel industry...It's been our main client and have not said 'hello' to anyone else and there was a lot of fruit on the tree and everyone got caught up in that and forgot the rest of the world 6W.* Similarly, some considered change to be hard work or simply a technological fix: *The size of the product is a barrier...Larger storage tanks don't fit into a container easily and the freight starts to become expensive....so in the end they just adopted a policy that said we were just a domestic organisation 5W.* Limited experience and resources to facilitate change internally was also evident: *We lack the knowledge of which doors to open...The business development link is critical, but when you are doing the work, you don't have time 7W.* Others appeared to be inhibited by a limited availability of

external upskilling expertise: ... *we still have our civil, mechatronics and environmental....but no engineering associated with advanced manufacturing.....they are still trying to push the guys to do a fitting and machining course or winding a handle on a lathe...4N.*

Responses indicate that the generational culture of some firms reflects paradigms of the past without change. Explaining such organisational viewpoints could also be attributed to the age and qualification profile of firm leaders. The vast majority of respondent firms (83.0 per cent) were established prior to 2000, 58.0 per cent of general managers within these firms were aged 50 plus years and had been with the company for over 10 years, and 92.0 per cent of these held a traditional engineering, business or marketing qualification obtained earlier in their management career. Arguably, in some cases, the leadership of firms lacked the skills and competences needed for a future manufacturing sector.

The above discussion presents an oxymoron for firms. Existing skills development represents the traditional legacy of historic manufacturing success where production and output was the main game. However, these practices limit absorptive capacity to integrate knowledge, skills and institutional reorientation to embrace a new culture of manufacturing in an era of global and technological change.

#### **4.4.2.3 Collaboration**

Table 4.1 illustrates the significance that a lack of collaboration has played across many manufacturing firms. For eight firms in particular, column one in Table 4.2 shows that collaboration remained internally motivated and although external alliance building was attempted, the ability, time available and strategic intent were limited. Firms tended to retreat to models of collaboration that employed quick wins by recruiting consultants or using internally based resources. Green and Roos (2012) identify these tactics as a 'demand side' deficiency in corporate strategy and culture for diffusing new ideas, techniques and undiscovered networks that could unlock new wealth.

Similarly, innovative collaboration within existing customer-supplier alliances was minimal. Within these partnerships, the objective of respondent firms was to deliver on current customer priorities and

contract deliverables rather than work together to explore sustainable alternatives or processes for adding value. Waiting for the customer to instigate sustainable practices does little to motivate a firm to explore an environmental point of difference and prevents development of new network potential. Instead, respondents react to pressure from customers concerned about sustainability through incremental process innovation such as adopting alternative communication and management systems, particularly when sustainability-related product innovation might compete with existing sales (Hockerts and Wüstenhagen 2010). These behaviours often anchor manufacturers into ‘business as usual’ thinking, reducing engagement in sustainable activity and locking the firm into an existing pathway.

#### 4.4.2.4 Technological

Table 4.1 indicates that significant financial and human resource investment was committed to physical capital development. Hence, all eight manufacturers in Table 4.2 were locked into existing technological strategies ensuring a return on investment, rather than exploring new production processes that could create efficiencies or niche-innovation. For example, four firms experienced ongoing operational pressures and preferred to secure manufacturing contracts that maximised the use of existing technology; this compelled these firms to apply short-term solutions to deliver rapid financial returns. Loorbach (2010) argues this ‘searching for work’ strategy locks a firm into a specific trajectory, influenced by the social, economic and cultural path in which firms originally develop, creating a dependence on traditional technology that prevents the take-up of potentially superior alternatives. Likewise, process innovation that creates lighter and stronger products, is associated with short-term technological solutions that improve profits and increase market share rather than generating internal sustainable and innovative thinking. For instance, 3G and 6W said:

*The change....is introducing some carbon fibre into our product. However, if it doesn't wear out, they don't come back and buy the product...laughs.....all our sustainability ideas revolve around efficiency, driving down costs and reducing water consumption 3G.*

*Historically, we have poured the precast concrete into a mould...now we have tooled up with a steel bed concrete mould...to produce a better product. We have changed the configuration of the mould to reduce costs and bring efficiencies ... 6W.*

Firms 3G and 6W operate within an existing technological trajectory. By embracing automation techniques and digital technologies, manufacturing firms can reduce costs (Advanced Manufacturing Growth Centre 2016), but with the right enabling conditions however, these strategies can simultaneously create sustainable product and process innovation.

Although Table 4.2 suggests eight firms maintain existing technological trajectories, research findings reveal that 16 firms are attempting to challenge this *modus operandi* and instead are exploring more transformative pathways. A summary of these actions in column two of Table 4.2 illustrates that 10 of the 16 firms are in the process of adjustment – a ‘tipping point’. These 10 firms, predominantly machining/metal/engineering manufacturers, are exploring innovative possibilities to generate profit, developing products that meet an established criteria of value whilst maintaining current technological trajectories (Boons 2009). At the same time, each firm is experimenting with niche and sustainable manufacturing opportunities. More specifically, column three of Table 4.2 demonstrates six (of the 16) firms implemented niche-innovations and were developing sustainable opportunities for the future. As a result, these six firms were shown to be reconfiguring the regime of the traditional manufacturing model. This reconfiguration perspective is discussed in the next section.

#### **4.4.3. Niche-Innovations**

Participant responses in Table 4.1 indicated that several manufacturing firms developed niche-innovations, positioning themselves for a stronger manufacturing future. Specifically, Table 4.2 illustrates that six firms embraced significant change, increasing their agility and transformative capacity towards a ‘Reconfiguration’ trajectory. The firms in this phase are small to medium enterprises and with one exception, represent building and construction technology, machining, engineering and chemical manufacturing sectors. Each displays an appetite for exploring advanced manufacturing techniques and niche-innovations for developing sustainable markets. Table 4.3 illustrates that the transition behaviours of the six reconfiguring firms encapsulate the following three attributes: strategic envisioning, tactical networking and operational innovation.



#### 4.4.3.1. Strategic Envisioning

Loorbach and Wijsman (2013) claim strategic envisioning is an essential step in shifting a firm towards a more sustainable trajectory. A sustainability vision was reflected in the core business strategies of all six firms. For example, 1G designed a whole product range to reduce carbon, 1W combined sustainable building techniques to create a healthier internal environment for people living in aged care, whilst 4W applied eco-friendly design principles to beautify and differentiate its product portfolio. A specified number of participants expressed the view that designing a vision for change was a strategic role for leaders and capable managers. For instance, 1G appointed a business coach and mentor to help reorient the company, 4W restructured its board of management to introduce innovative thinking and 9G transformed its business and cultural model to address future manufacturing trends and customer preferences.

Table 4.3: Niche-innovations examples for sustainable transitions

Niche Innovations		Contribution to Sustainable Transition
<b>Strategic envisioning</b>	Sustainable vision	Understanding drivers and barriers for change New product and market development opportunities
	Facilitating leadership and development of frontrunners	Building leadership capability in sustainability driven business
	Building workforce capability	Facilitating future skills development, knowledge in sustainability and innovation for manufacturing
<b>Tactical networking</b>	Knowledge based partnerships with researchers, customer and competitors	Exploring alliances to drive sustainable product and market opportunities Exchange of knowledge and skills to access sustainable markets
	New non-traditional partnerships	Partnerships based on knowledge and innovation rather than physical fabrication and cost reduction
<b>Operational innovation</b>	Technological	Advanced use and development of sustainable materials and consumption practices Improved sustainable production processes and technical efficiency
	Design-based Business model Culture of experimentation	Sustainable behaviour change and influencing customers through experimentation Business model driven by social, economic and environmental goals New ideas – materials, techniques, products, culture and people

Loorbach and Wijsman (2013) characterise such leaders as ‘frontrunners’; visionary people able and willing to engage in a creative process of ‘out-of-the-box’ thinking, involving the whole organisation in long-term change. In the firms studied, the enacting of change requires the leadership to employ a diversity of strategies to build workforce capability, resilience and internal knowledge, often supplementing traditional training regimes with alternative mechanisms. These alternatives include

blended recruitment, by appointing external candidates and newly qualified graduates to rejuvenate the workforce, empowering teams by engaging staff in community projects, collaborative learning strategies and design and innovation thinking.

#### **4.4.3.2. Tactical networking**

Roos (2016) suggests a stronger ‘co-opetition’ strategy; that is mutually beneficial collaboration between competitors that brings significant clustering advantages to a firm. This study found institutional and customer-supplier collaboration evident in all six niche-innovation firms. For example 9G said:

*We are working more with start-ups....and swapping exclusive manufacturing rights....so rather than engineering solutions, look at some other solutions to get the business and help our customers grow 9G.*

These firms relied on collaboration for access to skills, training and knowledge exchange. However, only one firm engaged in related industry or competitor alliances. The idea of co-operation with competitors raised suspicions for three-quarters of all respondents, because of the potential for anti-competitive behaviour and mistrust. Respondents suggested a third party would be needed to facilitate firm-to-firm collaboration and one large firm indicated the need to recruit a dedicated resource to facilitate stakeholder collaborations. Beise and Stahl (1999) claim that larger firms are more likely to collaborate than smaller ones due to the availability of resources and an orientation to benefit from researchers within academia. Yet, as Table 4.3 indicates, whilst 4W employs a dedicated ‘collaboration’ manager, a lack of resources did not lessen the efforts of the five smaller firms in seeking advantages of collaboration with researchers. Building an innovation culture within all firms was important, and in contrast to Beise and Stahl (1999), each viewed collaborative research as core business rather than an activity carried out within a separate department.

#### **4.4.3.3. Operational Innovation**

A growing body of literature argues that, where Australia has achieved success in global markets, it has been related to innovation in product performance and niche offerings (Advanced Manufacturing

Growth Centre 2016). The accelerating pace of scientific and technological development requires manufacturers to remain attentive to emerging technological based innovation, including social media and additive manufacturing opportunities. It is the overlap of existing and new technologies which Green and Roos (2012) claim generates break-through niche-innovations for creative destruction<sup>14</sup>. In terms of operational innovation, this study found that existing and emerging **technological** solutions combined with non-technological attributes such as **design-based** and **business model** innovation were evident in six firms considered in Table 4.3. Respondents indicated that current technological strategies were supplemented by digitalisation and automation processes to generate change. For example, 1G utilised social media to promote its products' sustainable benefits and 4W employed 3D printing techniques to meet client demand. Likewise, 1W developed digital technology platforms to improve design efficiency, reduce waste and experiment with sustainable building materials.

In addition, where technology-based innovation takes a 'component improvement leads to system improvement' view, **design-based innovation** adopts a 'system optimisation leads to user behaviour change' perspective (Green and Roos 2012). In the six firm transitions, design-based features were identified as niche-strategies to stimulate internal and external behaviour change (see Table 4.3). For example, in challenging societal building norms and practices, 1W built a sustainable home:

*...we did a pilot home...NSW<sup>15</sup> first 91/2 star home based on the German Passivehaus principle...triple glazed windows, heat recovery ventilation, thermally insulated...low toxin, energy management systems...collect the data and package it up...1W.*

2W collaborated with non-traditional alliances to design a new product:

*...the Blue Biotech Network getting... the (seaweed) extracts and looking at the research and finding out how to commercialise it... there is a lot of chemistry behind it...what is the best delivery and packaging system and how long does it stay active...all of these things haven't been explored as a functional pharmaceutical product 2W.*

1G trialled production outside the existing factory space:

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<sup>14</sup> According to Schumpeter, 'creative destruction' describes the process of industrial mutation that revolutionises the economic structure from within, destroying the old one and creating a new one (Schumpeter 1934).

<sup>15</sup> Australian state of New South Wales

*...we don't want to run a factory...we are working with two guys who are experts in their fields and they have access to factories, industry and Deakin University 1G.*

7G tested new technology with external clients:

*...we will start with two trials...a domestic trial with 150 households...see how scalable it is...a commercial trial...all the food waste and how efficient it is on three different technologies...we will run this through (Company x) which I have set up... 7G.*

4W used technology to experiment with idea formation:

*...we have a piece of software called the 'ideas factory' for capturing ideas...if an idea is admitted and resourced, we have a methodology called 'stage gate' to manage and steer it... 4W.*

By designing these strategies for experimentation, firms assess alternative routes for innovation and sustainability that challenge traditional internal behaviours while, at the same time, reorienting cultural norms and boundaries that stabilise the regime. Loorbach (2010) describes such pathways as 'shadow-tracks'; spaces of innovation that provide freedom of thinking removed from everyday business activity. These experiments identify new sources of growth based not just on a comparative advantage in new materials applied, but on the competitive advantage conferred by knowledge and ingenuity (Green 2015). Such narratives of experimentation combine information absorption with commercial gains to design future sustainable markets and build new associated value chains.

Scholars have also suggested that business model redesign is key to a strategic transition (Bocken et al. 2014). This provides a source of sustainable differentiation that moves beyond unit costs of production, high volume and low value manufacturing, and positions these firms at the niche level of the global value chain. In this study, as Table 4.3 shows, these six firms recognised the need for **business model innovation**; strategically rethinking the sustainability and business case value proposition and thus, re-conceptualising their firm's purpose.

## 4.5. Reflections

This chapter proposes a refinement of sustainable transition thinking, by integrating complementary features from the advanced manufacturing framework. This proposal results from examination of a

number of limitations in both literatures for combining manufacturing and sustainability related activity, to open up fresh opportunities along the value chain (Qian 2014). The transitions literature on business transformation has revealed important insights on how organisations might practically engage in a sustainable transition (Loorbach and Wijsman 2013). However, scholarly contributions have tended to focus on societal change, but rarely on an individual business or across businesses. In addition, to date, academic studies have not been conducted in the traditional manufacturing sector. Another limitation of the transitions literature, has been the focus on European based firms where the geographical, institutional and political context differs from other developed countries. Thus, analysis within an Australian setting brings a new institutional perspective and insight into a national manufacturing sector in decline, attempting to reposition itself towards advanced manufacturing of which sustainability is a core element. Yet, the politics and established regimes internal to firms and within government inhibit such a transition.

The Attributes of a Sustainable Transition conceptual framework attempts to respond to the gaps in the literature and explain this transition phenomenon in a new dimension which has yet to be theoretically and practically articulated. The conceptual framework in this thesis enables a systematic analysis of 24 firms' existing business strategies that currently hold eight firms back but propel 16 others forwards. More specifically, the theoretical framework enables an exploration of what this prescribed change looks like when six firms engage in a sustainable reconfiguration across three analytical system levels including landscape pressures, socio-technical regime factors and niche-innovations.

First, the review of the landscape pressures demonstrates the complex macro socio-technical forces of change currently impacting on Australian manufacturing. Challenges associated with climate change, globalisation, technological development and a growing knowledge economy, influence the uptake of adaptation initiatives in firm production processes and outputs. Such initiatives are adversely impacted by domestic industrial and political sustainability rhetoric, that discourages any actor commitment towards a sustainable transition, knowledge spillover or scaling up of niche-innovations. This rhetoric reinforces an emphasis on incremental change and does little to stimulate a sustainability agenda. Upon aggregating the 24 case study responses, these findings underline the difficulties traditional manufacturing firms face in tackling broader system level impacts and interactions. However the

theoretical framework, specifically a multi-level perspective and transition management approach, illustrates how analysis of an individual firm can inform a wider system response to reconfigure the manufacturing sector towards a sustainable transition.

Second, socio-technical regime factors particularly inhibit a sustainable transition for eight of the firms. Figure 4.6 illustrates that two firms remain fixed in a position of status quo and six in resource efficiency mode. As a result, the business case for sustainability, transformational leadership and workforce development is missing, with firms relying on autocratic management styles and internal knowledge and training strategies to improve performance. Such approaches which effectively maintain the traditional regime, may partially reflect the experience and perspectives of over half the study respondent sample, who are aged 50 years or over and who have progressed to senior management through the company. Rather, a sustainable and innovative shift requires a future manufacturing sector to employ a range of diverse skills and initiatives, to build contemporary management and workforce transition capability and create future leaders (Department of Industry, Innovation, Science, Research and Tertiary Education 2008; Green et al. 2009).

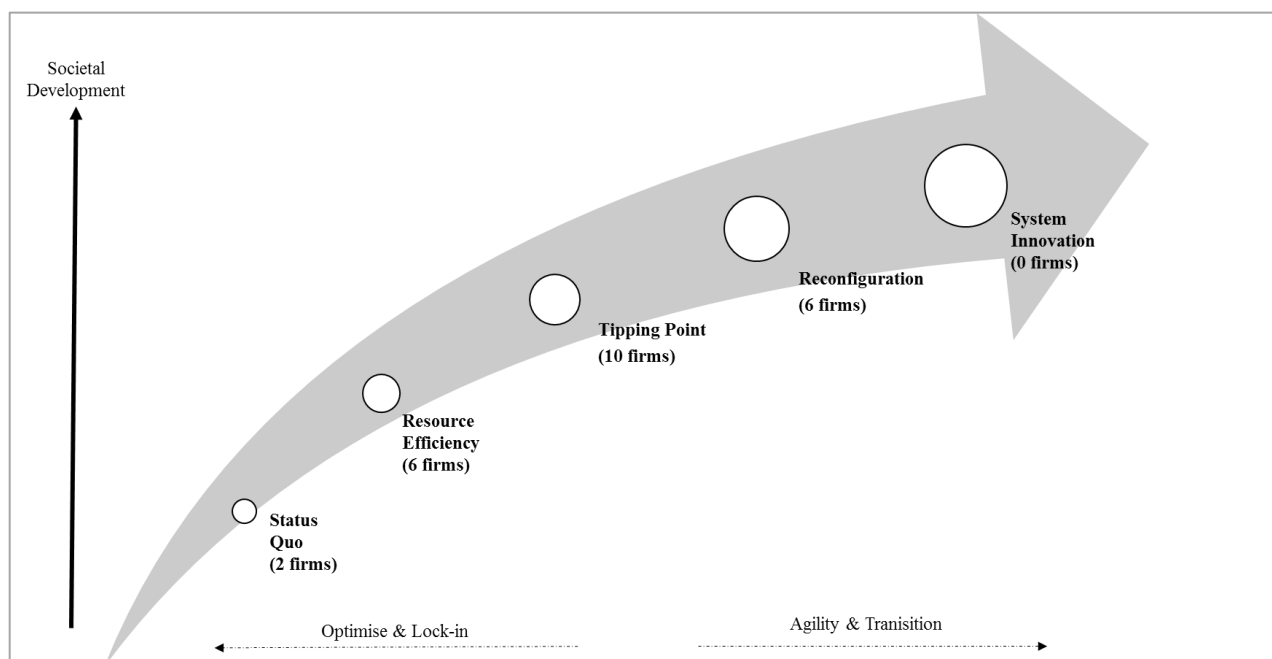


Figure 4.6: Transition trajectory of 24 case study manufacturing firms (adapted from Rotmans, Kemp and Asselt 2001)

Additionally, in terms of collaboration and networking, the preferred model for forging partnerships and sharing knowledge tended to rely on internal firm collaboration rather than external alliance building. Hence, although a reputation for collaboration is one of the key features international networks seek when trading with an Australian company (Advanced Manufacturing Growth Centre 2016), such a quality was absent across all firms within this study. Challenges experienced within these eight firms are compounded by the multi-national governance structure of the firm. Whilst the research findings indicate such an ‘arms-length’ management approach limits levels of autonomy and entrepreneurial initiative, and maintains existing production regimes, Tether (2002) argues that such a model offers alternative advantages. These include access to branding, investment market development and knowledge resources at a global level.

The ten firms on the ‘Tipping Point’ of a transition were also constrained by socio-technical regime factors. The process of adjustment is building within the firms and the current system is beginning to shift in response to global trends and product innovation (Loorbach and Rotmans 2006; Green et al. 2009). Yet, where these firms excel in technological advancement they fall behind in non-technological elements such as collaboration and networking, building leadership and workforce capability as well as rethinking the business model to address sustainable challenges (Loorbach and Wijsman 2013).

Third, six firms are ‘Reconfiguring’ towards a transition, developing niche-innovations for sustainable markets. These firms illustrate the implementation of system level change strategies that integrate economic profit with social and ecological value (Moore and Manring 2009) and position sustainability within core business. Boons (2009) describes these firms as ‘transformative’; establishing a new technological trajectory in order to provide a product or service with reduced ecological impact, whilst also displaying a broad range of niche attributes that require a technological, social, institutional and cultural systems rationale. Such attributes include: a) a sustainable vision stimulating a shift in cultural mindset; b) engaged frontrunners and interdisciplinary teams to develop key priorities and goals; c) leadership and sustainable transition management capability; d) renewed manufacturing skills and knowledge; e) combined technological, design-based and business model innovation; f) sustainability experiments; and g)

diverse collaborations across research, industry and customer-competitor alliances.

However, engaging in continuous reflection and learning for monitoring sustainability performance is a key transition process element and this research found it was missing from all 24 firms. This omission probably contributed to an absence of firms represented in the system innovation phase, depicted in Figure 4.6. Whilst each of the six reconfiguring firms embraced elements of transition dynamics, they did not set out to design and implement a formal systematic manufacturing transition strategy, rather assembling it as a piecemeal solution. Therefore, refining the socio-technical narrative through the lens of advanced manufacturing and sustainable transitions, demonstrates how a more customised tool could contribute to a manufacturing shift, if purposefully applied as a systematic transition framework. Such modification is guided by the advanced manufacturing concept which specifically focuses on the technological and non-technological requirements of a future manufacturing sector and how traditional models of operation need to adapt. At the same time, it introduces a new disciplinary language into the realms of sustainable transition theory.

The multi-level perspective identifies barriers and opportunities both for change and for how the internal components of a system, both dominant and emerging, might interact to inform processes for managing a transition. The concept of transition management enables the identification of significant leverage points, particularly in processes of governance, institutions and areas of convergence that can be built upon to steer a future trajectory. Collectively, both the multi-level perspective and transition management approaches build upon the notion that a holistic or systemic shift, rather than an optimisation of a traditional manufacturing mindset, is required to redesign practices in key economic sectors (Loorbach and Wijsman 2013). The combined theoretical dimensions connect the more conceptual and visionary aspects of transition research with the practical steps needed to attain advanced manufacturing production techniques, networks and capability development, bringing sustainability to the forefront of manufacturing. In other words, for sustainable transitions to occur, both long-term envisioning and in-the-field practice are required (Neuens et al. 2013).



Drawing more general conclusions, the research findings demonstrate firms struggle to reshape existing systems where the manufacturing regime is stabilised. A reconfiguration towards sustainable business operations is easier to undertake where destabilisation has begun to occur. Conversely, analysis suggests that while cracks are emerging, the manufacturing regime still seems fairly resistant to addressing the impacts and opportunities presented by climate change and sustainability. This finding is reinforced by three-quarters of participants who are neither fully committed to acknowledging these challenges, nor placing them high on their priorities, preferring to employ a range of conventional approaches involving incremental change. It is not everyday practice for manufacturers to re-evaluate the underlying features of current markets, internal business models and innovative strategies related to sustainability. Yet, as a quarter of respondents indicated, doing this carries significant potential given the right enabling conditions.

At the same time, these features present a paradox as incumbent manufacturers reshape relevant societal systems. On one hand, they are core actors providing products and services for everyday use (Augenstein and Palzkill 2015). On the other hand, these same firms do not contribute to sustainability in the way these functions are fulfilled. To survive in cut-throat competition and meet shareholder dividend targets, with under-producing factories, a low-skilled workforce, firms tend to focus on pricing strategies and maintaining the status quo. Thus, three quarters of respondent incumbent manufacturers impede structural change even though they have the capabilities, resources and influence to achieve significant adjustment on a broader scale (Augenstein and Palzkill 2015).

## **4.6. Conclusion**

This chapter has argued for a new theoretical approach, in response to contributions by Geels (2012), Green and Roos (2012) and Loorbach and Wijsman (2013); these researchers have called for an identification of the components, functions and dynamics at play during system transitions within the manufacturing sector. For a sustainable transition, a business needs a holistic strategy incorporating social, cultural, institutional, technological, environmental and economic values rather than an optimisation of current regime behaviour. In addition, this chapter has responded to Markard, Geels and Loorbach (2010), who sought to explore transition dynamics in differing geographical, political

and institutional contexts.

The Attributes of a Sustainable Transition conceptual framework along with the empirical research presented, provide a useful lens for successfully navigating a strategic firm and system level transition. If facilitated and adopted more generally, broader understanding of how social, political and institutional differences of the firm context influence the transition process, can also contribute towards guiding policy makers to develop lower carbon transition strategies within the manufacturing sector. Whilst the concept of advanced manufacturing dominates the political-economic agendas of many advanced countries, including Australia, a theoretical contribution combining sustainable transition theory brings sustainable manufacturing to the forefront of policy making. As Joglekar, Davies and Anderson (2016, p.1985) note, in this case ‘it is important to understand strategic issues in a single “micro-context” before branching out into the wider “macro-world” - industrial firms are far more complex in their strategies, operations, uses of people and relations to each other and their suppliers than business or economic theory describe or than statistical data can capture’. Thus, a refined sustainable transition framework encourages and enables a more nuanced and inclusive approach for analysing an incumbent sector missing from the current theoretical debate. At the same time, it presents a common language to underpin government policy implementation, and support practical sustainable innovation and societal transformation in a manufacturing context.

Future research could investigate the overlap between the ‘Resource Efficiency’ and ‘Tipping Point’ perspectives and the ‘Tipping Point’ and ‘Reconfiguration’ perspectives. Such analyses could further explain the difficulties of shifting the regime; they would also underpin study of radical and experimental niche-innovations for transitioning firms, together with contributing to policy design for future manufacturing models. Although the empirical analysis reported here is based on manufacturing firms located in Australia; for a more generalised and comparative insight, future studies could explore other regions or countries with spatial transition challenges, contexts and opportunities. This chapter has empirically applied the first part of the Attributes of a Sustainable Transition theoretical framework (Advanced Manufacturing, Sustainable Transitions) at the level of the firm. Individual analyses such as these provide insight in transformative change for policy makers as well as firms, while also facilitating understanding of the dynamics of a scalable transition at the system level. The

next chapter combines the insights from this chapter with the perspectives of various regional actors who are key to addressing broader system level challenges of the transition process in the context of place.

## Chapter 5

### Transitioning a manufacturing region – a spatial insight

This chapter examines how and why specific transitions take place within different geographic categories, in this case city regions. It does so by building on evolutionary economic geography studies to analyse the transformational and spatial transition attributes of three Australian city regions within traditional manufacturing settings. The chapter combines individual firm sustainable transition insights with the perspectives of wider regional actors, by merging the second part of the Attributes of a Sustainable Transition conceptual framework presented in Chapter 3 – ‘Regions are Spatial’ with a ‘Transition Regions’ approach. Following the introduction, this chapter is organised as follows. Section 5.2 provides an overview of the theoretical framework applied to inform the city region analysis (see section 3.4 for a detailed literary review). Section 5.3 presents the research approach and methodology (see Chapter 2 for a detailed methodological analysis). Section 5.4 discusses the empirical evidence across each case study region and section 5.5 summarises the key arguments as a basis for drawing conclusions in section 5.6.

The text below has been prepared for submission to the *Journal of Economic Geography* – the Abstract is included in Appendix I. References are incorporated in the combined thesis list and linking comments to Chapter 6 added at the end.

#### 5.1.Introduction

Integrating sustainability into everyday business practice is a new dimension in the ongoing process of manufacturing change. There is a broad literature seeking to understand how creating economic value could also limit ecological impact and increase social responsibility (Hart and Milstein 2003; Jovane and Westkämper 2009; Loorbach and Wijsman 2013; Gibbs and O'Neill 2014) (see Chapter 3 for extended detail). But most existing publications are centred on the firm, societal or national unit of analysis, identifying geographically-specific factors that facilitate transition initiatives. For instance, Loorbach and Wijsman (2013) analyse how individual businesses tackle sustainability and innovation challenges, Jovane and Westkämper (2009) and Qian (2014) explain how sustainable production

methods can benefit firms and wider society, and Raven, Schot and Berkhout (2012) explore a national context where large firms are constructing clean energy projects.

A key deficiency of these studies is in identifying the role that place performs, in guiding the manufacturing sector towards a sustainable and innovative transition. This omission limits a broader understanding of the regional social, institutional and political dynamics of transformational change. While some scholars have begun to explore these shifts in Europe (Coenen, Moodysson and Martin 2014; Cooke 2013; Loorbach and Wijsman 2013), this chapter aims to contribute further through a focus on the Australian manufacturing context, particularly in three Australian city regions.

Truffer, Murphy and Raven (2015) emphasise that in many contexts, a solely national analysis of industry dynamics, lacks legitimacy. Adding a local level of investigation is essential since national policy is shaped by institutions in many regions and communities (Peck 2002). Research that builds an understanding of the complex relationships and activities that occur in regions is therefore critical (Peck 1996; Van Winden et al. 2010). Gibbs and O'Neill (2014) call for detailed inquiry into sustainable economy development in particular places that examines not only the role of businesses in directing renewal, but also the role of national and local policies, institutions and intermediary actors. Such a response would not only identify attributes of sustainable transitions in spaces and places, but also present opportunities for new path creation in industrial regions that have relied on traditional systems of production.

As previously mentioned, by the late 1950s Australian manufacturing contributed up 29.0 per cent of Gross Domestic Product (GDP), but by the 1960s the manufacturing sector had begun to stagnate. In more recent decades it has been in decline, falling to 6.8 per cent of GDP in 2011 (Milne 2010). External factors such as globalisation, high exchange rates, increased labour costs and more recently a reliance on resource extraction (Green and Roos 2012), contributed to the decline. Internal regimes of low value, high volume production models have further negatively impacted the industry's contribution to GDP. At the same time, the effects of climate change and pursuit of a lower carbon economy (Organisation for Economic Co-operation and Development 2011; United Nations Environment Program 2014b) have required firms to adapt systems in new and innovative ways, positioning environmental and social sustainability within the economic value chain of production. Determining

how to make this sustainable and innovative transition is a challenge for many incumbent<sup>16</sup> industry and supporting intermediary actors.

This chapter builds upon transition and evolutionary economic geographic studies to analyse transformational challenges and spatial attributes of 24 manufacturing firms in the construction, chemical, heavy engineering, machining and metal industry sectors within three Australian city regions: Geelong, Wollongong and Newcastle. Whilst all three city regions continue to replicate their existing capability within related industries, Geelong is strategically positioning itself to meet the demands of a lower carbon economy, by developing capability unrelated to its traditional knowledge and institutional base. By contrast, Newcastle and Wollongong are adapting and utilising existing knowledge and technological expertise to create new sustainable innovative opportunities in related sectors, but are unable to mainstream these new niche activities as a result of path-dependent bottlenecks.

## **5.2. Geographies of Sustainable Transitions – a transition regions framework**

Transition research emerged about 20 years ago (Rip and Kemp 1998; Geels 2002), exploring factors contributing to sustainable transitions, the transformation of technological regimes and the role of innovation through the multi-level perspective (MLP) (see section 3.4 for a detailed literature review). As a heuristic framework, the multi-level perspective describes the opportunities and challenges that a sustainable shift may encounter across three analytical levels: landscape (macro), regime (meso) and niche (micro). In developing a sustainable economy, one key task is to explore how activity within and across these levels might challenge and replace dominant socio-technical regimes, which are characterised by stability and path-dependence.

Whilst transition studies provide frameworks for analysing processes of diversification within the socio-technical regime, a major critique of the approach has been that it is less effective in identifying which systematic attributes of a place are more responsive to new path creation (Boschma et al. 2016). Critics argue that this perspective has failed to adequately account for the influence of space in reshaping traditional industries towards a more sustainable trajectory (McCauley and Stephens 2012; Bos, Brown and Farrelly 2014). By engaging with economic geography and regional studies, however,

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<sup>16</sup> Refers to the 'past' holder of a market or previous dominant form of industry or actor, which is now becoming redundant <http://www.investopedia.com/terms/i/incumbent.asp>

transition scholars can begin to address these spatial limitations and examine how and why transitions take place in different geographical settings. This multi-disciplinary approach illustrates the governance challenges for translating locality specifics, particularly for emerging clean technologies and niche formations that are contingent on place specific factors (Hansen and Coenen 2015). For example, in Hamburg, Gothenburg and Curitiba, local authorities collaborated with industry to explore sustainable transport solutions. In Boston (USA), the concept of ‘clean technology’ was embraced by engaging a range of actors including investors, researchers, government agencies, business and institutions within a broader environmental agenda. These examples illustrate that city regions can facilitate sustainable transitions when place is understood as comprising relationally embedded actors (Truffer and Coenen 2012).

In the case of manufacturing, Van Winden et al. (2010) propose that firms are part of regional, national and global networks and consequently, dynamics cannot be understood without considering their contextual relationships and spatial attributes. Silicon Valley is a prime example of a regional ecosystem comprising a range of networks and relationships, rather than a focus on individual firms (Bahrami and Evans 1995). If socio-technical transitions, which are regionally embedded and place-transforming, can destabilise existing regimes (McCauley and Stephens 2012; Truffer and Coenen 2012), it is crucial to understand the strategies that firms adopt to alter the system context in which they operate. These strategies include the creation of new partnerships, norms, values and practices to foster sustainable change (Hansen and Coenen 2015). Sustainable economic development can be unevenly distributed in space and depend on an interplay of actors, networks and institutions available in some places and not in others. Every region has innovative potential, but that potential may differ due to particular industrial and technological specialisations, knowledge and networks intertwined within place.

Responding to limitations in the existing scholarly literature, Cooke (2013) presents a ‘Transition Regions’ framework, which draws on work in evolutionary economic geography (Boschma and Frenken 2006; Frenken and Boschma 2007; Nelson and Winter 2009) to ground socio-technical transitions in geographic space. This concept has contributed significantly to exploring the uneven geographical landscape of transition frameworks; it helps address questions such as: why industries

concentrate in space? How networks evolve in space? Why some regions grow more than others? As well as how institutions co-evolve within industrial dynamics of regions? This approach rethinks a city region transition across three distinct conceptualisations, including relational, institutional and evolutionary aspects.

First, reconsidering the region beyond physical boundaries conceptualises place as bound in a network of relations (see Chapter 3 for a detailed literature review). In this regard, Massey's (1979) work was pioneering in that it stimulated a variety of geographers including Peck (1996), Allen, Massey and Cochrane (1998), Hudson (1999), Morgan (2004) and Cochrane (2012), to rethink how regions are positioned. Massey's (1979) demonstration of the importance of place, conceived as having multiple identities as a process rather than a frozen place in time, called for analyses of spatial relations between actors and institutions in regions; and it was subsequently key to understanding the economic, political and power dynamics in different geographies (Truffer, Murphy and Raven 2015). Understanding place is becoming increasingly important within global production networks, where a proximity of actors and manufacturing precincts influence the development of interfirm relationships and collaborations (Hansen and Coenen 2015). Such relational analyses focus on ways in which social networks influence inter-organisational partnerships and facilitate collaboration between geographically distant partners.

A second key element of transition regions is its focus on regional institutions. Diverse relationships' and networks' are intertwined within the institutional and spatial landscape of a region, (see Chapter 3 for extended literature detail). These institutions comprise organisations such as industry bodies, trade unions and regional development agencies, as well as forms of social regulation including ideas, norms, culture and rules (Skellern, Markey and Thornthwaite 2017). Coenen and Truffer (2012) articulate these elements as signs of 'institutional thickness' or a measurement of regional innovative leadership. Successful regional attributes of 'thickening' indicate the presence of partnerships built on innovation, trust, cohesion and a progressive sense of place (Amin and Thrift 1994), which are critical for implementing effective transition policies (Pearce and Stilwell 2008 ). Research in Sweden has suggested that systematic industry and labour retraining initiatives driven by regional actors, have enabled exploration of alternative manufacturing paths. This distinguishes businesses there from other geographies, including Australia, on a national and international scale (Pearce and Stilwell 2008).



Evolutionary change is a third key element of the transition regions approach. It draws on evolutionary urban (Jacobs 1969) and innovation economic (Schumpeter 1934) frameworks to unpack the evolving and historical path-dependent nature of a system (Asheim, Boschma and Cooke 2011; Binz, Truffer and Coenen 2015). Firms that replicate organisational routines and stable rules, preventing innovation and new path creation (Coenen, Moodysson and Martin 2014), are constrained by three fundamental factors. First, dense *political* relationships preserve traditional industrial structures and restrain alternative direction setting. Second, a common *cognitive* mind-set amongst actors reinforces ‘group think’ and reduces creativity for new ideas. Third, strong *functional* interfirm networks block alternative alliances and a reorientation of the value chain (Asheim, Boschma and Cooke 2011). Skellern, Markey and Thornthwaite (2017) advocate the importance of understanding these restraining characteristics as historical layers of cultural, political, economic and ideological activity of a place (Massey 1995). These play a particular role in both the development and diffusion of environmental innovations (Hansen and Coenen 2015). Thus, research has presented strong evidence that the formation of new industries is deeply rooted in related historic activities in a region. For example the City of Pittsburgh, partnered with former steel manufacturing and machining related firms, by combining new technology with existing capability to produce niche components for medical devices (Svensson, Klofsten and Etzkowitz 2012). Related characteristics, such as shared activities and competences, stimulated a ‘knowledge spillover’ between organisations, regional actors and institutions.

Importantly, although some research indicates the value of related diversification, other studies have found that unrelated diversification can be just as important for long-term economic development (Boschma et al. 2016). Unrelated diversification occurs when a region develops a new activity, requiring a very different set of capabilities, and tends to be driven by state policy or other actors that have built expertise elsewhere. In a transition region, the more a new industry is unrelated to existing regional capability the more it will make a radical departure from its own past (Cooke 2013). Boschma et al. (2016) propose a regional diversification typology that identifies enabling and constraining conditions for a transition at the spatial scale. This typology contains the following four diversification strategies:

- Replication: duplicating an existing capability base by branching into related activities, replicating existing knowledge, institutions and interests embedded in an existing socio-technical regime,
- Transplantation: developing an industry unrelated to its knowledge base and institutions, yet based on adopting a regime technology from the global system,
- Exaptation: discovering new applications for existing knowledge or technology, and
- Saltation: developing a new niche that is new to a region and to the world.

Combining the diversification strategies illustrated in Figure 5.1 with the multi-level perspective, frames a transition regions analysis for this study.

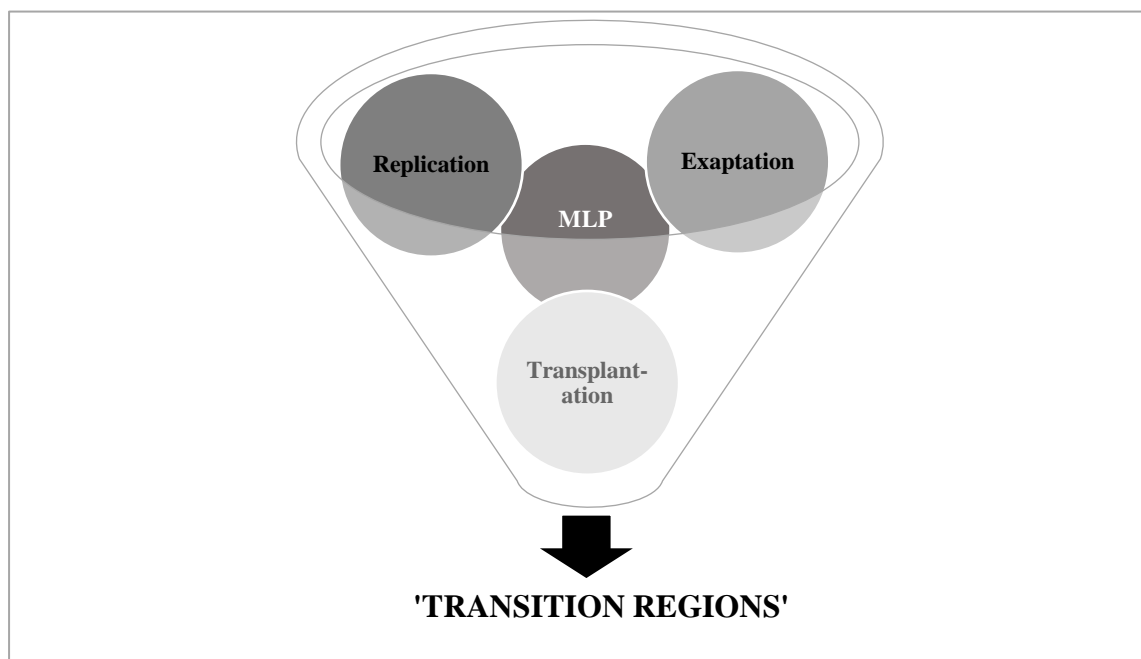


Figure 5.1: Transition Regions (adapted from Skellern, Markey and Thornthwaite 2017). Note: The saltation strategy has been omitted (as no firm displayed these diversification attributes).

### 5.3. Research Methodology

This chapter employs a comparative case study approach to identify the sustainable and innovative transition attributes of three Australian traditional manufacturing city regions. Although prior studies have employed similar qualitative methods (Tripl and Otto 2009; Coenen, Moodysson and Martin 2014), these are largely based on single locations of study, with minimal comparative analysis

involving firms or stakeholders in different city regions. A comparative approach enables an examination of similar and diverse themes within and across cases to evaluate the applicability of the transition regions framework (Eisenhardt 2007).

A regional diversification typology differentiates between related and unrelated specialisation, whereas a multi-level perspective considers the niche and landscape factors that challenge the existing socio-technical regime. Combined, both conceptual approaches explore possibilities for a manufacturing transition in each city region. Table 5.1 classifies each of the 24 city region firms according to their typology positioning. For example, whilst each city region employed a replication strategy by branching into related activities, Geelong firms predominantly engaged in a Transplantation diversification strategy and Newcastle and Wollongong in an Exaptation strategy. Section 5.4 elaborates on these transition dimensions.

Table 5.1: Typology of diversification (Boschma et al. 2016)

		CITY REGION	
		Related	Unrelated
MANUFACTURING SECTOR	Regime	<i>Replication</i> All Firms (3G, 5G, 6W replication only)	<i>Transplantation</i> 1G, 2G, 4G, 7G, 9G, 2W, 3W
	Niche	<i>Exaptation</i> 1N, 2N, 3N, 4N, 5N, 6N, 7N, 8N, 6G, 8G, 1W, 4W, 5W, 7W	<i>Saltation</i> No Firms

The selection of city regions was based on the presence of the following socio-economic characteristics: proximity to a capital city; Australian east coast location; rich industrial legacy; level of structural industry adjustment; and facilitation of innovation and sustainability oriented initiatives (see section 2.3 for a synopsis of attributes for each city region). Manufacturing firms were selected and recruited in consultation with local industry representatives based on their level of product and process

innovation spanning the previous five to ten years (see section 2.3 for an overview of recruitment methods).

A semi-structured interview of one to two hours was conducted with each general manager of 24 separate manufacturing firms. To guarantee anonymity, interviews are cited in the results section using the acronyms in Table 5.1. For example, 1N represents one firm interviewed in Newcastle, 2N represents a second and likewise for Geelong and Wollongong. In addition, one focus group involving intermediary actors was organised within each city region to explore policy insights and the institutional agenda for transition. Discussion outcomes were audio-taped, transcribed verbatim, coded and themed using qualitative data analysis software, NVivo and the regional diversification typology (Boschma et al. 2016).

### **5.3.1 City region overview**

Each city region has historically contributed significantly to its respective state economy, Newcastle and Wollongong by way of steel and mining in New South Wales, and Geelong via wool, gold and automotive production in Victoria. However, since the 1970s and 1980s, each city region has been impacted by a weakened manufacturing sector, structural inertia and a growing service sector. Figure 5.2 illustrates employment growth across the top three contributing service sectors in each city region, compared to manufacturing occupation between 2006 and 2016. While employment has grown strongly across the Retail Trade, Education and Training and Health Care and Social Assistance sectors in all city regions, manufacturing employment in the Hunter and Illawarra regions has remained steady.



Figure 5.2: Top three contributors to industry sector of employment by city region compared to manufacturing (Source: Australian Bureau of Statistics Gross State Product 2013; 2014 National Input Output Totals; and 2006, 2011b Census Place of Work and Employment Data)

Overall economic output between 2006 and 2016 was not available to enable comparison by employment sector and city region. However, Figure 5.2 illustrates that when comparing each wider city region's contribution to employment and economic output by sector, the Hunter more convincingly contributes across all four sectors compared to G21<sup>17</sup> or Illawarra regions. In addition, whilst Figure 5.2 outlines growth in significant areas of service sector employment, when analysing economic output, the manufacturing sector remains a significant generator of wealth for each city region economy (Figure 5.3), far outweighing the three service sector outputs combined.

<sup>17</sup> G21 is the formal alliance of government, business and community organisations in the Geelong region over five member municipalities – Colac Otway, Golden Plains, Greater Geelong, Queenscliff and Surf Coast.

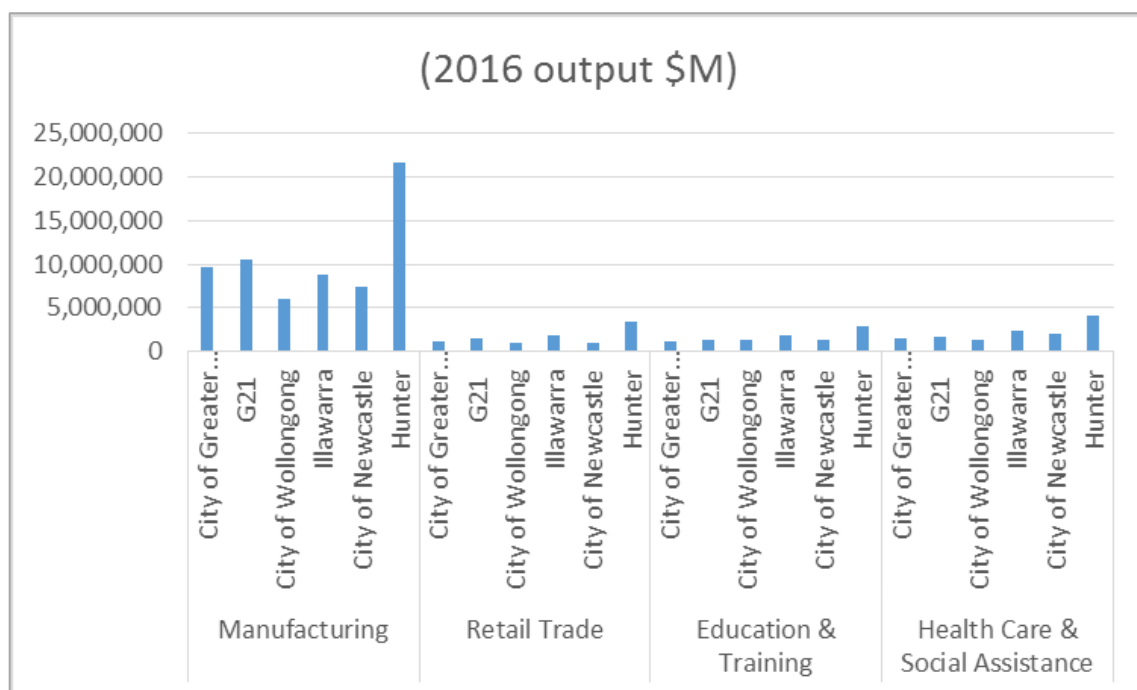


Figure 5.3: 2016 industry economic output by city region (Source: Australian Bureau of Statistics Gross State Product 2013)

Much of this new manufacturing growth is attributed to ‘related’ forms of manufacturing, with traditional forms of production across each city region in varying phases of decline. For example, the Newcastle BHP Steel Plant closed in 1999, and whilst the community rallied to protect the city region’s economy, steel manufacturing was eventually replaced by coal mining and exporting. As a consequence, manufacturing in Newcastle and the wider Hunter region comprises firms that once supplied the steel industry and now generate niche products for mining and equipment technology and other similar sectors. Figure 5.3 indicates the ongoing strength of the manufacturing sector in the wider Newcastle region, in terms of economic output in 2016, despite the downturn in traditional steel manufacturing.

In Geelong, the 2016 closure of Ford automotive production triggered community wide action, with an allocation of government funding provided to assist regional diversification. Whilst Figure 5.2 shows that the decline in manufacturing employment in Geelong has been incremental, the comparable rate of growth and employment in other service sectors across the wider city region has remained steady, although growing in the Education and Training as well as Health Care and Social Assistance sectors. In contrast, BlueScope Steel remains a major employer and drawcard for the manufacturing supply

chain across the Wollongong city region and surrounding Illawarra area. However, since 2010 the company has dramatically reduced domestic steel production, decommissioned one blast furnace and reduced employment levels and external contractor arrangements. This trend is reflected in Figure 5.2, where employment levels in Wollongong manufacturing firms have fallen since 2006, but employment has grown strongly across the Health Care and Social Assistance sector.

Associated changes in the demographic and socio-economic characteristics across the three city regions are also contributing factors to the demise of manufacturing. While the general labour market and economy is more favourable in Newcastle and Geelong than Wollongong, both Newcastle and Wollongong are experiencing slower population growth rates, due to a decline in the number of jobs and workers migrating to other regions. The Sydney labour market for example, draws approximately 12.0 per cent of the workforce from Wollongong (NSW Trade and Investment 2015). Additionally, both Geelong and Wollongong demonstrate a higher percentage of unskilled and semi-skilled workers and fewer professionals and managers than Newcastle (IRIS Research 2016; Regional Development Victoria 2016).

All three city regions encompass a range of intermediary and knowledge-based institutions. In particular, there has been an acceleration in advanced medical, materials development and clean-technology research capability across a range of university and research institutions. Road, rail and port infrastructure enable access to each city region, with the Port of Newcastle being the largest in Australia. Geelong and Newcastle both provide domestic capital city flights from regionally located airports. The next section describes the sustainable and innovative transition findings of each city region, aligned with the relevant typology criteria described in section 5.2.

#### **5.4. Spatial attributes of a transition region – key findings**

Building on the background discussed in section 5.3, this section explores the spatial attributes and challenges of a sustainable and innovative transition of the three city regions. The analysis includes examination of the 24 case study firms across the four typology trajectories which Boschma et al. (2016) describe (Replication, Transplantation, Exaptation and Saltation). Separate tables (5.2 – 5.4) provide summaries of the specific city region transition activities, mechanisms for change and details of the transition process.

### **5.4.1 Replication**

Within each city region, a dominant trend for respondent firms is to replicate their current capability base in related sectors: knowledge, experience and institutions that are embedded within the existing socio-technical regime. As Table 5.1 shows, all the case study firms exhibited this replication strategy of branching into related activities. For example, Table 5.2 illustrates that in Newcastle, 6N replicates its existing electronics and vehicular materials' manufacturing capability within the electric vehicle socio-technical regime, blending local and non-local networks and tacit knowledge to diversify into a related sector. In Geelong, 2G replicates its polypropylene shower base manufacturing expertise to produce eco-friendly alternatives (Table 5.3). In Wollongong, 7W replicates its steel and engineering design skills to develop mattress recycling technology (Table 5.4). These findings correspond with Boschma et al's. (2016) view of a replication strategy as a typical model for regional incumbents with strong markets, history and brand positioning; because it provides a low risk opportunity to access new sectors that are related to existing operations. Such patterns of replication are attributed to the key notions of path and place-dependence, and are influenced by the landscape and socio-technical regime characteristics identified using the multi-level perspective (see section 3.4); this includes political uncertainty, cognitive lock-in and functional impediments to change.

#### ***Political Uncertainty***

Levels of uncertainty, which are associated with limited government appetite and policy commitment for change, tend to lead to a replication of the existing socio-technical regime for manufacturing firms, preventing future path disruption (Truffer and Coenen 2012). Changes in energy policy provide an example of this policy ambiguity in Australia. For instance, the Australian Federal Labor government introduced the Carbon Price legislation in 2011, as part of the Clean Energy Future Plan, to increase energy efficiency as well as investment in sustainable and renewable technological solutions. However, after a change of government in 2014 the law was repealed, contributing to the scheme's demise, and triggering revaluation of industrial policy and investment scepticism about sustainability initiatives across the manufacturing community. Across all firms' studied, this domestic indecision has stifled sustainability, caused confusion and reduced industry confidence. Moreover, increasing global competition and trade has created inequalities for exporting firms, which lack access to the subsidised land, wages and tax free concessions that other countries adopt to facilitate and stimulate local



manufacturing activity. Whilst Elder (2016) argues free-trade is better for the economy as a whole, it also creates winners and losers. Measures to alleviate such pressures are often not well implemented, presenting a challenging operating environment for an exporting oriented city region.

Six Newcastle firm interviews and focus group discussion revealed that business leaders were concerned about current industry policies that inhibited transformational change. For instance, issues concerned trade protection initiatives, procurement strategies based on cheapest price, general cost of doing business and arduous regulations and standards that slowed down efforts to transition. All firms were of the view that entrenched political norms strongly favoured the resource extraction industry to the detriment of other more advanced and sustainable forms of manufacturing. Research participants also articulated that innovative attributes such as taking risks, market agility, entrepreneurial enterprise and foresight to combine sustainable and technological strategies were missing from Australian policy design. Respondents considered that policy makers preferred to preserve traditional industry structures and pathways that maintained the existing regime.

Similarly in Geelong, the perception that policy agendas were of a centralised, top-down nature, rather than incorporating a locally-based response, particularly frustrated interview respondents; this influenced a replication strategy across the city region. Focus group sentiment revealed that policy makers maintained minimal empathy for contemporary regional development challenges, reacting to regional adjustment instead with what respondents considered to be archaic models of change. All Geelong firms experienced frustration with the centrally managed grant funding process, which overlooked local nuance and represented 'big' business interests; it also bred distrust, and lacked vision for regional adaptation.

These diverse responses indicate the city region challenges of political lock-in, which preserves the existing regime, together with associated policies and actors, are unresponsive to local and spatial diversity, consequently inhibiting alternative directions for industry development (Coenen, Benneworth and Truffer 2012). Vested interests embedded in national governments, limited resources and a lack of spatial comprehension, hinder significant structural change and the opportunity to support long-term transition trajectories, which Beer and Lester (2015) argue are critical for the future sustainability of regional Australia.

Table 5.2: Newcastle Transition Region

Firm	Today	Tomorrow	Relatedness	Transition process	Level	Knowledge mechanisms/actors	Type of knowledge	Proximity
1N	Composite manufacturing	De-sulphurisation, design and manufacture wave technology & sustainable materials	Related	Replication Exaptation	Regime Niche	Entrepreneurship, Customer collaboration, Skilled labour, Learning by doing/informal know-how sharing, Multi-site collaboration.	Tacit Codified Tacit Tacit	Local/Non-local Local/Non-Local Local/Non-Local Local/Non-Local
2N	Manufacturing of commercial catering equipment	Servicing, maintenance & education in sustainable equipment use	Related	Replication Exaptation	Regime Niche	Collaboration with customer, Learning by doing/informal know-how sharing, Intermediary organisations.	Codified Tacit Codified	Local Local Local
3N	Traditional machine manufacturing & fuel management systems	Energy management systems	Related	Replication Exaptation	Regime Niche	Skilled labour, R&D, University of Newcastle (UON), Learning by doing/informal know-how sharing.	Tacit Codified Tacit	Local/Non-Local Local Local
4N	Glass facades and machining	Turbine blades, medical, aerospace	Related	Replication Exaptation	Regime Niche	Skilled labour, R&D Hunter Manufacturing Research Institute, Collaboration with customer, Learning by doing.	Tacit Tacit Codified Tacit	Local Local Non-local Local
5N	Mining infrastructure	Wind turbine components for civil	Related	Replication Exaptation	Regime Niche	Skilled labour, Multi-site collaboration, R&D (external)	Tacit Tacit Tacit	Non-local Non-local Non-Local
6N	Lightweight deployable structures/vehicles, high end electronics	Electric vehicle development/ Power electronics	Related	Replication Exaptation	Regime Niche	Multi-site collaboration, Skilled labour, Entrepreneurship, Learning by doing/informal know-how sharing, Collaboration with customer.	Tacit Tacit Tacit Tacit Codified	Local/Non-Local Local Local Local Local/Non-Local
7N	Electrical engineering in mining	Design and manufacturing solar modules, modular design	Related	Replication Exaptation	Regime Niche	Skilled labour, Learning by doing, Collaboration with customer/supplier.	Tacit Tacit Codified	Non-Local Local Non-Local
8N	Underwater technology	Wave technology	Related	Replication Exaptation	Regime Niche	Skilled labour, Entrepreneurship, Collaboration with customer/supplier, Firm to firm in research group, Learning by doing.	Tacit Tacit Codified Tacit Tacit	Local Local/Non-Local Non-Local Local/Non-Local Local

Table 5.3: Geelong Transition Region

Firm	Today	Tomorrow	Relatedness	Transition process	Level	Knowledge mechanisms/actors	Type of knowledge	Proximity
1G	DIY sustainable products	DIY Eco-Glaze	Unrelated	Replication Transplantation	Regime Regime	Intermediary organisations, Skilled labour, R&D Deakin University, Learning by doing.	Codified Tacit Codified Tacit	Local Local Local Local
2G	Poly-propylene shower bases	Eco friendly shower bases	Unrelated	Replication Transplantation	Regime Regime	Intermediary organisations, Workshop, Learning by doing.	Codified Codified Tacit	Local Local Local
3G	Paper-making machines	Paper making/carbon fibre machine	Related	Replication Exaptation	Regime Niche	R&D (Deakin), Multi-site collaboration, Collaboration with customer	Codified Tacit Codified	Local Non-local Non-local
4G	Control system design and manufacturing	Design and build computer technology for manufacturers – large scale solar engineering	Related	Replication Exaptation Transplantation	Regime Niche	Skilled labour , Informal know-how sharing, Conferences, Learning by doing, Collaboration with customers, Intermediary organisations, Links to communities of practice.	Tacit Tacit Codified Tacit Codified Codified Tacit	Local Non-local Non-local Local Local Local/Non-local Local/Non-Local
5G	Ammunition	Distribution ammunition & accessories	Related	Replication	Regime	Multi-site collaboration, Collaboration with customer.	Tacit Codified	Non-local Local/Non-Local
6G	Carpet	Renewable carpet/recycling product	Related	Replication Exaptation	Regime Niche	Collaboration with supplier, Learning by doing, Skilled labour. Industry association.	Codified Tacit Tacit Codified	Non-Local Local Local Local/Non-Local
7G	Recycled food packaging	Organic Composting Technology (residential & commercial)	Unrelated	Replication Transplantation	Regime Regime	Entrepreneurship, Learning by doing, Links to communities of practice, Intermediary organisations, R&D Commonwealth Scientific & Industrial Research Organisation (CSIRO).	Tacit Tacit Tacit Codified Codified	Local/Non-local Local Local Local Local
8G	Radiators	Heat exchangers for solar installations	Related	Replication Exaptation	Regime Niche	R&D (CSIRO), Collaboration with customers, Intermediary organisations, Learning by doing.	Codified Codified Codified Tacit	Local Local/Non-local Local Local
9G	Engineering in automotive industry	Engineering Applications, medical/environmental industries	Unrelated	Replication Transplantation	Regime Regime	Collaboration with customer, Entrepreneurship, Firm to firm collaboration, R&D (Deakin), Conferences/workshops, Intermediary organisations, Learning by doing.	Codified Tacit Tacit Codified Codified Codified Tacit	Non-Local Local/Non-Local Local/Non-Local Local Local/Non-Local Local Local

Table 5.4: Wollongong Transition Region

Firm	Today	Tomorrow	Relatedness	Transition process	Level	Knowledge mechanisms/actors	Type of knowledge	Proximity
1W	Timber residential construction	Cross laminated timber (CLT)/9* homes construction	Related	Replication Exaptation	Regime Niche	R&D University of Wollongong (UOW), Intermediary organisations, Learning by doing Collaboration with customer, Conferences, Links to communities of practice.	Codified Codified Tacit Codified Codified Tacit	Local Local Local Local Non-local Non-local
2W	Chemical manufacturing	Pharmaceutical - algae production	Unrelated	Replication Transplantation	Regime Regime	R&D (UOW), Intermediary organisations, Workshops, Learning by doing, Skilled labour.	Codified Codified Codified Tacit Tacit	Local Local Local Local Local
3W	Steel truss and frame construction	Modular design & bathroom pods	Unrelated	Replication Transplantation	Regime Regime	Learning by doing, Collaboration with customer.	Tacit Codified	Local Local/Non-Local
4W	Raw steel making	Resilient & energy efficient building products	Unrelated	Replication Exaptation	Regime Niche	R&D (universities),  Skilled labour, Conferences/workshops, Links to communities of practice,  Multi-site collaboration,  Collaboration with suppliers/customers.	Codified  Tacit Codified Tacit  Tacit Codified	Local/Non-Local Local Local Local/Non-Local Local/Non-Local Local/Non-Local Local/Non-Local
5W	Hot water tanks	Energy efficient hot water heaters	Related	Replication Exaptation	Regime Niche	R&D (UOW), Multi-site collaboration, Learning by doing.	Codified Tacit Tacit	Local Non-Local Local
6W	Steel & Engineering	Civil & Safety	Related	Replication	Regime Niche	Collaboration with suppliers, Learning by doing.	Codified Tacit	Local Local
7W	Steel & Engineering	Mattress recycling machinery	Related	Replication Exaptation	Regime Niche	Entrepreneurship, Collaboration with suppliers, Learning by doing, Conferences, Intermediary organisations.	Tacit Codified Tacit Codified Codified	Local Local Local Non-local Local

### *Cognitive Lock-in*

A second bottleneck fostering replication is associated with cognitive lock-in. For instance, research findings indicate that a 'group think' mind-set and tendency to reflect on past manufacturing success, have precluded creativity and imaginative transformative thinking amongst Geelong firms; similarly among a range of Wollongong actors, this contributes to replicating of the socio-technical regime. For four Geelong firms, sustainability is a 'cost', evidenced by a culture of incremental technological change. The regime is compelled into taking sustainable action only if it reduces costs, employing a 'have to' rather than 'want to' mind-set. Additionally, longstanding institutions in Geelong prioritise the past over the future. For example, focus group participants remarked that consistent negative media discourse has focused on factory closures, whilst ignoring innovative business champions and jobs created in sustainable industries. This agenda undermines attempts of transition management oriented leaders to employ a sustainable and innovative change agenda, and instead continues to replicate existing processes.

Similarly, findings indicated that place-dependence motivates a replication strategy in Wollongong. This city region maintains a historical reliance on the steelworks to provide jobs, government to guide economic development and physical infrastructure as the basis for growth, reflected in areas of 'most important' and 'best serviced' in Figure 5.4. Figure 5.4 also signifies the reliance of firm networks on local, state and national levels of government as well as the importance of material infrastructure (e.g. road, rail), over building knowledge or capability for driving the city region forward. Even as the steelworks downsize, Wollongong focus group participants nurture a dependence trajectory, with the view that one dominant enterprise should be replaced by another; and that pursuing new infrastructure projects provides short-term solutions for jobs and growth. Focus group discussion revealed the relational and socio-technical fabric of the Wollongong city region was dominated by traditional industry, which led to cognitive lock-in and preserved existing structures and jobs (Trippel and Otto 2009). Even though the Retail Trade, Education and Training and Health Care and Social Assistance sectors have grown within the city region (see Figure 5.3), historic ties and actions of 'the usual suspects' sustain a traditional view; this is not conducive to transition processes or reorienting manufacturing to take advantage of new opportunities within growth industries. Likewise, three firm

respondents conveyed a complacent dependence on the steelworks for business survival, negating any chance for change or reflection on the importance of innovative business models.

An attempt to transition Wollongong towards a lower carbon economy in 2009 led the New South Wales Government to introduce the policy initiative ‘Green Jobs Illawarra’. Whilst some success was achieved across this program, once funding ceased, momentum retreated to replicating existing capability and direction. Such a perpetual path and place-dependent challenge prevents actors pursuing alternative approaches to transition manufacturing and traditional sectors.

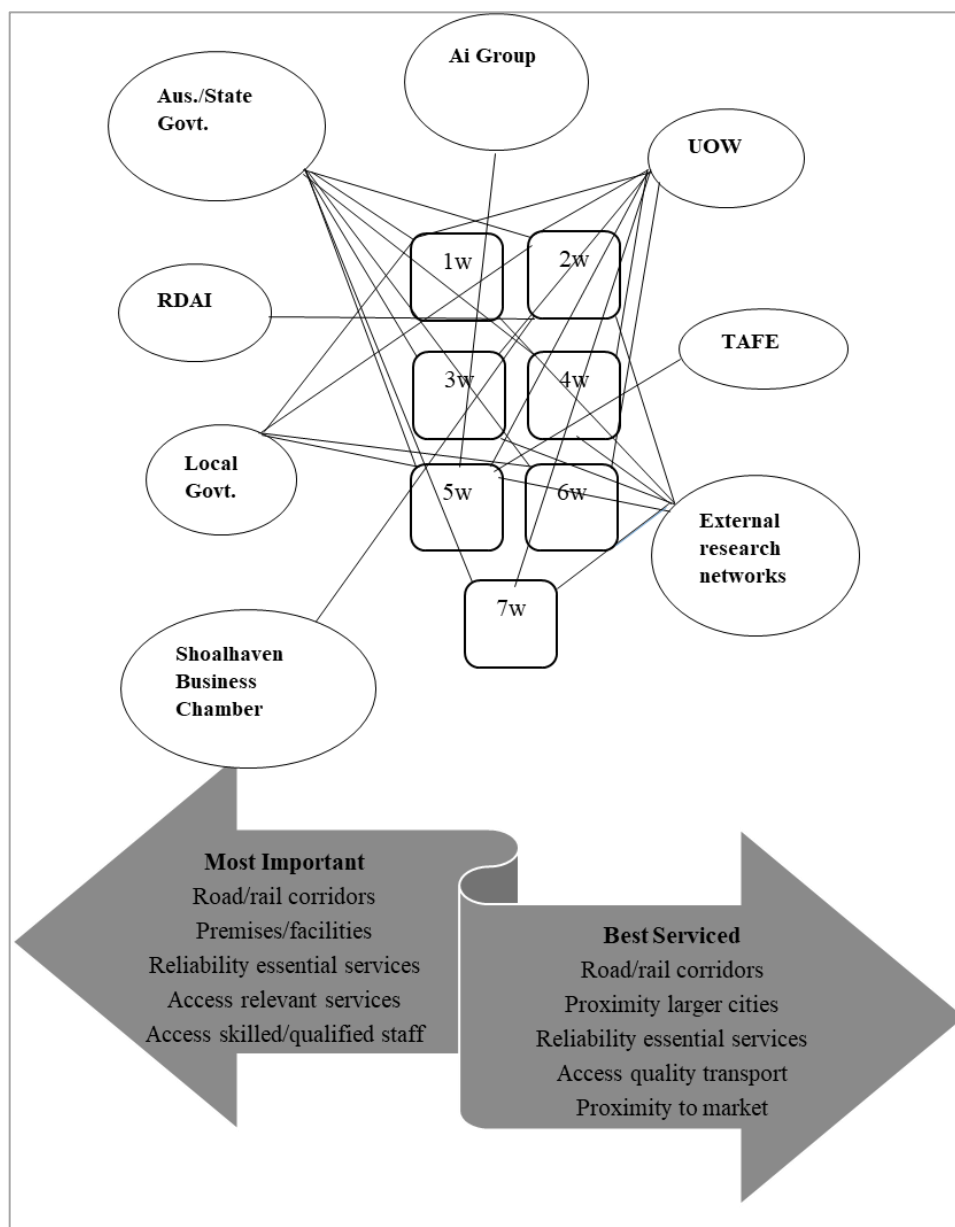


Figure 5.4: Wollongong Network Map. Note: Ai Group (Australian industry Group), UOW (University of Wollongong), TAFE (Technical and Further Education College), RDAI (Regional Development Australia, Illawarra).

### ***Functional Impediments***

A third factor sustaining a replication trajectory involves functional impediments such as existing sunk<sup>18</sup> investments in out-dated infrastructure and technology. In both Geelong and Wollongong, these factors have led firms to create strategies that optimise existing capital assets (Cooke 2009). For four Wollongong firms and four Geelong firms, a key resource advantage of their region has been its proximity to truck, train and ship transport infrastructure (see Figures 5.4 and 5.5), a feature which is characteristic and a legacy of the traditional manufacturing economy (Van Winden et al. 2010). In contrast, for Newcastle firms, reliable access to a local airport was considered a significant city region advantage because it enabled connections with relevant skills, knowledge and capability assets outside the region (see Figure 5.6). One respondent noted: *The people that we want to partner with in the future are not here. They are in Sydney or Melbourne....the airport provides us good access to these partners* (3N). Although Geelong has an airport in close proximity that services domestic capital cities, convenient flight timetabling remains a challenge, and the alternative drive to Melbourne's airport is hindered by road congestion.

Other functional bottlenecks associated with existing sunk technology were operating in the firms studied. For example, four Geelong firms justified the significant cost of maintaining existing equipment, saying that upgrades or purchasing new technology depended upon its return on investment to the business. Consequently, these firm's interpretation of innovative related change focused on creating production efficiencies simply to assist in reducing manufacturing costs - so preventing a reorientation of the value chain. Similarly, while Wollongong steelworks have scaled back in size, the company's continued operation nonetheless dictates local employment levels, a specialisation mind-set, and the perception of an old industrial region, ultimately steering a replication pathway. Two firms and focus group participants illustrated the dominance of the steel supply chain on interfirm networks across the city region, for example: *Historically we have centred on the steel industry. It's been our main client and have not said hello to anyone else...and everyone got caught up in this and forgot the rest of the world* (6W). A strong specialisation in mature clusters prevails in Wollongong, highlighting

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<sup>18</sup> In economics and business decision making, a sunk cost is a cost that has already been incurred and cannot be recovered [https://en.wikipedia.org/wiki/Sunk\\_cost](https://en.wikipedia.org/wiki/Sunk_cost)

the risk of reliance on a narrow and specialised economic base, preventing diversity and innovation in products and markets.

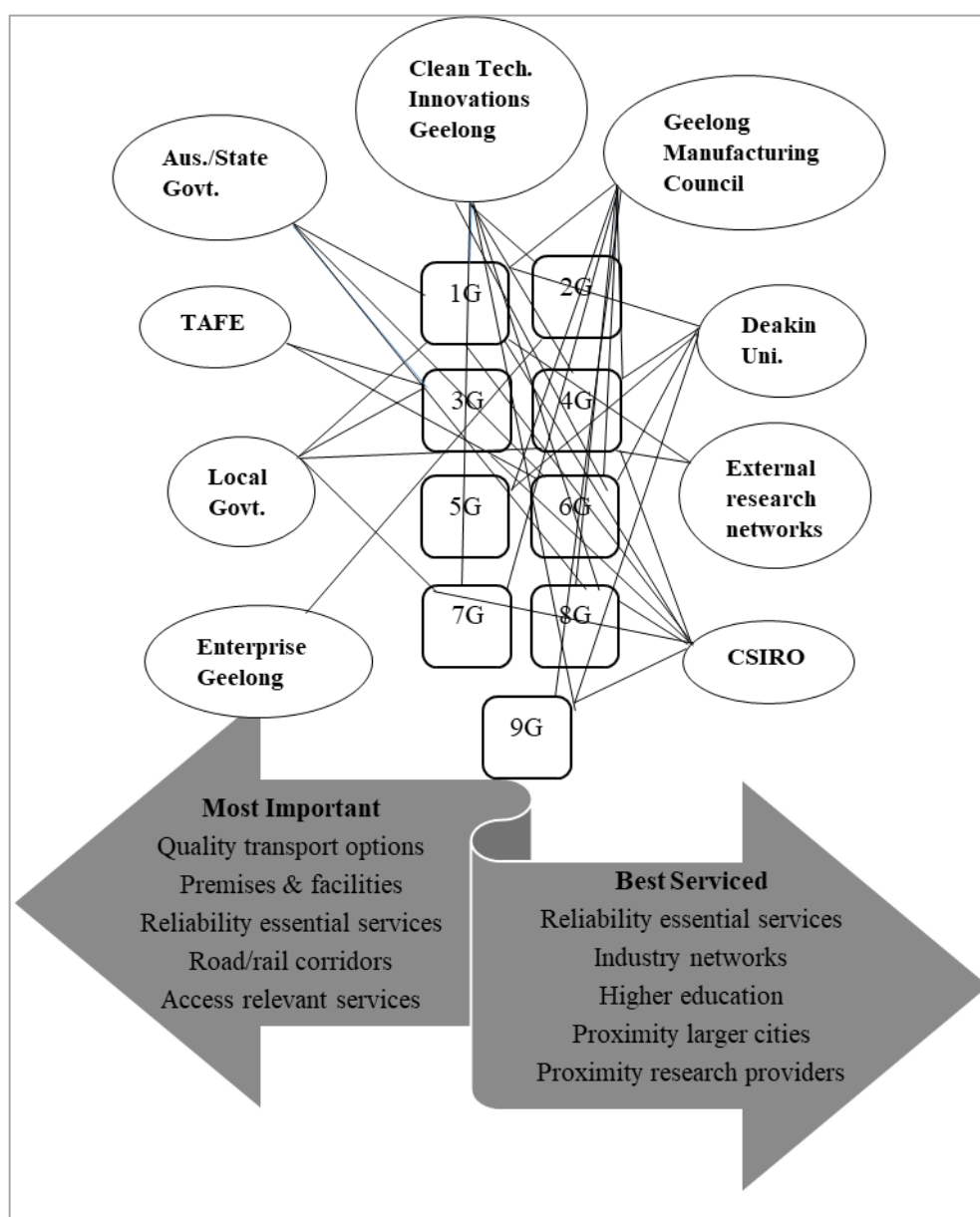


Figure 5.5: Geelong Network Map. Note: CSIRO (Commonwealth Scientific and Industrial Research Office)

By comparison, findings in Newcastle indicate that the legacy of the steelworks, ship and rail industries has facilitated the development of alternative networks, organisational strategies and a reorientation of the value chain. The shift in 1999 from steel-making to mining enabled Newcastle firms to build on existing skills and capability to develop technology and equipment that supported the mining sector. This transition enabled firms to manufacture across a range of technological platforms including



sustainability, illustrated in Table 5.2. Rather than relying on one large, single conglomerate entity to supply employment opportunities, smaller and medium sized firms exhibited the diversifying attributes needed to facilitate growth and transition. For instance, these firms employed technological innovation strategies, knowledge alliances and global partnerships, within a range of related and niche industries that built upon the traditions of the city region. Although divergent replication has occurred in each city region, the next section shows that alternate diversification strategies are also emerging.

#### **5.4.2 Transplantation**

While replication has been a feature of all firms in all regions studied, transplantation diversification has been adopted widely in Geelong, to a lesser degree in Wollongong and not at all in Newcastle. Tables 5.1 and 5.3 illustrate that over half of Geelong respondent firms are executing a transplantation strategy; that is, developing an industry which is unrelated to its knowledge base and institutions, yet based on adopting a regime technology from the global system (Boschma et al. 2016). For Geelong, this shift is accelerated by the key role intermediary actors' play in seeking to understand the types of knowledge and mechanisms required, in order to exploit the city region's niche competitive advantages. For example, the strength of network connections between Geelong firms and research driven institutions including the CSIRO and Deakin University is mapped in Figure 5.5. Also productive are the diverse range of collaboration efforts initiated across the city region. For instance, following implementation of the Geelong Low Carbon Growth Plan and market analysis of growth industries in 2013, the Geelong Manufacturing Council, in partnership with the City of Greater Geelong and the Victorian Government, initiated Clean-Tech Innovations Geelong. This assemblage is a regional development initiative designed to capitalise upon and strengthen existing local capabilities, to pursue a transition towards a lower carbon economy.

Further legislative support from the Victorian government provided a policy instrument to encourage commercial building owners to invest in sustainability retrofits. This triggered opportunities for local manufacturing to diversify into an unrelated sector. As a result, Geelong focus group participants credited the contribution of intermediary action to the region's embrace of manufacturing's key strengths and to establish itself as a clean technology and sustainability centre of excellence. For five Geelong firms pursuing transplantation pathways unrelated to the region's traditional automotive and

heavy engineering past, this path had been triggered by collaborative partnerships with local intermediary and knowledge actors, shown in Table 5.3. For example, 2G acquired the latest knowledge in sustainable production processes and invested in new technology to recreate a standard bathroom shower base into an environmentally-friendly alternative. This initiative reduced the product's carbon footprint and weight, at the same time improving efficiencies in installation and transportation to the customer. Niche markets and a consumer base in high end apartment living and remote mining communities were also identified. Firm 9G partnered with the crematorium industry, a previously unrelated alliance to existing collaborations, to manufacture geo-polymer burial systems, leading to a reduction in the amount of green-house gases emitted in comparison to traditional concrete production processes. These transplantation strategy examples are supported by intermediary actors with the capability and interest to diffuse a firm's potential path dependence in relation to the existing regime, and champion a sustainable and innovative transition platform (Boschma et al. 2016). This inspires trust and collaboration across the city region through shared norms and values.

However, even though there is an institutional and governance agenda supporting sustainable and innovative transition in Geelong, challenges remain. For example, tensions have grown amongst local policy stakeholders supporting central government funding objectives, rather than promoting the region's competitive strengths. Research findings show that this division inhibits the speed of transition across the city region. Interviews and focus group discussions indicated that overcrowding of local agencies with multiple and complex agendas was causing confusion and change apathy. Figure 5.5 illustrates the complexity of these multiple network connections.

These challenges are intensified further by a deficiency in local skill levels. An audit conducted by Snell and Gekara (2013), to ascertain the level of sustainability-related capability across Geelong, demonstrated that 33.0 per cent of respondents faced difficulties recruiting suitable staff to fill clean technology job roles. This finding corresponds with 75.0 per cent of current research participants, who confirm that staff are mainly semi or un-skilled. Four Geelong firm respondents and focus group participants suggested that local education institutions were not keeping pace with the contemporary capability building needed for a sustainable and innovative transition; with only two of the four respondent firms accessing courses via the local TAFE institution. These are largely skills associated

with higher-end engineering, design, production and sustainable management rather than lower level generic operational skills. The reality of the skills deficit was confirmed in responses by all three city region focus groups and firm interviews, with participants noting that existing knowledge infrastructure is strongly oriented toward traditional industries and technological fields. As a result, all firms tend either to substitute external training with in-house training or, as three firms revealed, rely on poaching skilled labour from other organisations (see Tables 5.2, 5.3 and 5.4). Whilst such strategies may introduce new capability to the firm, such recruitment tactics can tend to import existing norms, behaviours and costly distractions which may inhibit change.

At the same time, for six Geelong firms and four Newcastle firms, attempting to acquire knowledge through research partnerships became problematic. Successful innovative collaborations between the firm and research institution were stymied by ‘language and commercial expectation’ differences. For instance, it was perceived by firm respondents, that manufacturers and universities hold opposing views on commercialisation timeframes. Manufacturers assumed a short term (six month) research-implementation project turnaround, which contrasted with the longer term approach (up to three years) expected by a university engaging PhD researchers for project delivery. As a substitute, ‘learning by doing’, via relational networks and informal knowledge exchange was common practice across all firms in each city region, tending to supplement and even replace scientific research alliances indicated in Table 5.3. This behaviour indicates the importance of face-to-face interaction and corresponding collaborative partnership dynamics. However, as Asheim and Gertler (2005) argue, such a localised proximity and short-term mindset may limit future transition opportunities. If relations become too durable with few ‘outside’ contacts this may build trust but limit learning or innovation, maintaining the status quo.

A transplantation pathway is not confined to the city region scale. Although Wollongong as a whole is not engaged in a strategic transplantation transition, two firms located on the periphery of the city region demonstrated unrelated diversification attributes (see Table 5.4). The experience of 2W in advancing biotechnology in Australia provides an example. Firm 2W is engaged in a collaborative ‘blue bio-tech’ partnership to create a future sustainable industry, bolstered by its proximity to substantial aquatic resources, including a vast coastline and local water supply. Such a relational

illustration aligns with Boschma et al.'s (2016) theory, that a transplantation strategy can also be successful if factors (e.g. natural resources) other than knowledge and proximity of institutions and intermediary actors are leveraged.

Likewise, 3W places innovation and sustainability at the centre of its manufacturing construction business, employing efficient and environmentally-friendly building practices. In a new factory facility integrating systems to reduce waste and increase efficiency, 3W applied modular design techniques to manufacture a range of bathroom pods for aged care and education facilities across New South Wales; there are plans to extend the technology to broader construction applications. For 3W, the transition strategy defies the city regions cognitive lock-in to traditional industry structures. Instead, it reflects an industry reorienting towards a burgeoning growth sector and creating a niche market in health and medical related manufacturing activity. Like 2W, 3W considers that it was not assistance from intermediary actors in Wollongong's institutional base, which facilitated its diversification. Rather, it was the proximity and connectivity to niche domestic markets and external networks (Figure 5.4) which created an opportunity for developing sustainable products and processes.

### **5.4.3 Exaptation**

Whilst transplantation is not the strategic intent for Newcastle or Wollongong, exaptation strategies have steered the prospects of a sustainable and innovative transition for both city regions. Tables 5.2 and 5.4 indicate that as well as replicating existing knowledge, eight Newcastle and four Wollongong firms position current manufacturing knowledge and technology to generate sustainable niche innovations in related sectors (Boschma et al. 2016). For example, 7N utilises its existing electrical engineering strengths to design and manufacture modular components for large remote solar installations, a non-traditional business space for this firm. While 7W uses its steel machining and fabrication expertise to build technology to recycle mattresses.

As Figure 5.6 and Table 5.2 illustrate, an exaptation strategy and network connections in Newcastle are supported by intermediary actors, global tacit and codified knowledge, research partnerships and a blend of local and non-local collaborations. For instance, the manufacturing innovation agenda is led by non-government industry representatives including the Ai Group and Hunternet<sup>19</sup>, which employ

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<sup>19</sup> Hunternet - Newcastle region's industry association.

techniques such as industry roundtables, trade exhibits and international collaborations to promote advanced technological capacity of the sector in pursuit of niche opportunities.

In addition, the presence of non-local knowledge networks contribute to the implementation of an exaptation strategy in Newcastle. Of the eight firms interviewed, seven are 'group owned' by national or multi-national corporations; this positions them within a global innovation network with access to expertise not available locally. Firms belonging to wider company groups are able to draw on a broader range of resources (Tether 2002), and in this case, global networks have provided Newcastle with niche production, partnering and knowledge opportunities. Asheim, Boschma and Cooke (2011) illustrate that non-local linkages within distributed knowledge networks are often crucial for learning and innovation, to avoid cognitive lock-in and stimulate path breaking innovation. Several firm respondents reflected upon the growing importance of such extra-regional networks:

*We have a global opportunity now with the way locomotives refuel just by working with Pacific National. Once you fix one problem and you have a successful relationship, it is easy to talk about it and you are trusted 3N.*

*We have adapted some of their (Teledyne) equipment and now when I go back in October...the idea is to try and get that into their options list...connecting into their global supply chain 8N.*

*Now we spend more time with Allstom in France...to see how we can contribute to their global supply chain... 1N.*

Research findings indicate that for Newcastle firm respondents, it is also important that local employment opportunities are socially and economically driven from within the region. Figure 5.2 shows the strong employment outcomes within the Hunter region across all four sectors including manufacturing. The mix of small to medium enterprises and multi-national corporations, located in the region's advanced manufacturing sector, helps to achieve locally facilitated growth by providing diverse employment opportunities. Unlike Geelong and Wollongong, access to a pool of qualified skilled labour in Newcastle is seen as the most important attribute to the day-to-day business of all firms (see Figure 5.6). For example, 8N appointed nine local engineers with Science, Technology, Engineering and Maths (STEM) qualifications. Nonetheless, five firms also acknowledged the need to

obtain external knowledge to stimulate new ideas, learning and innovation for successful exaptation.

This was particularly the case for 4N and 8N:

*There is very little (training) in Australia for digital manufacturing...there is nothing I can send these guys to at TAFE or University...it is cheaper for me to put a guy on a plane to Los Angeles to do these courses than it is to send them to Sydney 4N.*

*So the vendors come over from the US or Europe and train us...for example, SONAR run the course on how that works in the ocean... 8N.*

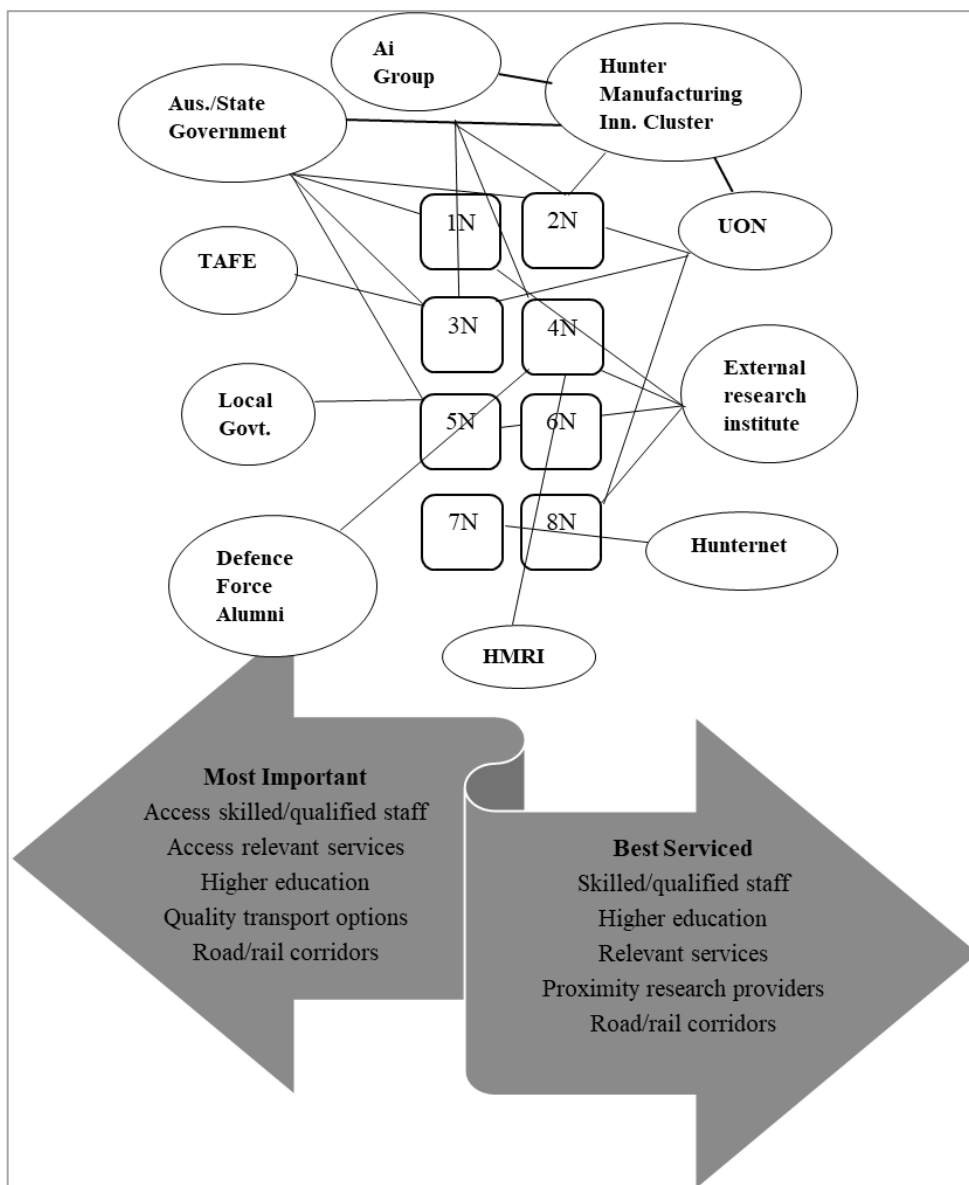


Figure 5.6: Newcastle Network Map. Note: HMRI (Hunter Manufacturing Research Institute), UON (University of Newcastle)

In contrast to Geelong and Wollongong, as Table 5.2 shows, Newcastle blends local and non-local dimensions of learning, which enables firms to source alternative collaborations for change. This was highlighted by three firms which, because they specialise in producing niche products not associated with the knowledge or specialised expertise of local research institutes, needed to seek external partnerships beyond the city region. Research and knowledge networks in Wollongong however, tend to be facilitated locally, by the Southern Manufacturing Innovation Group (see Table 5.4). This Innovation Group encompasses a local university cluster that connects manufacturers with internal researchers to generate new ideas, innovative processes and commercialise future technologies.

Finally a unique attribute in pursuit of an exaptation strategy, for three firms in Newcastle and one in Wollongong, has been the development of entrepreneurial partnerships in related industries. For example, in recognising its limitation in developing battery storage and associated manufacturing technology, 6N invested in a start-up firm to pursue advanced power electronic and battery-operated technological capability. Similarly, to access renewable technology markets, 8N supplied a small start-up enterprise with engineering expertise to build a wave power prototype and 7W initiated an alliance with an inventive sole-business to manufacture mattress recycling equipment. These local entrepreneurial knowledge mechanisms are bridging the gap between existing know-how and application. Cooke (2013) illustrates that this related proximity attribute involves cognitive and relational dimensions which facilitate rapid knowledge transfer among entrepreneurs and managers; in turn, this supports a stronger economic platform for a transition region.

#### **5.4.4 Saltation**

The fourth of Boschma et al.'s (2016) diversification strategies, saltation, refers to an innovation that is new-to-the-region and new-to-the-world. Such a transformation is both unrelated to a region's capabilities and challenges an existing global regime. For transplantation and exaptation diversification, the region or regime bestows supporting institutional structures, whereas a saltation strategy requires a fundamental change of institutions both regionally and globally. Saltation attributes were not found to be evident in any of the city regions studied.

## 5.5. Discussion

This chapter has described the spatial attributes and barriers of a sustainable and innovative transition for three traditional manufacturing city regions in Australia. It broadens understanding of spatial dynamics missing from transitions analyses by extending the enquiry to characteristics of transformational change in a city region context. The transition regions conceptual framework combines sustainable transition and evolutionary economic geography approaches to determine the drivers and obstacles for renewal across three diversification trajectories: Replication, Transplantation and Exaptation.

This analysis of three traditional manufacturing locations in Australia found that each city region employs a replication strategy of branching into related activities as part of its strategic path towards revitalisation. Whilst this chapter concurs with Boschma et al. (2016) that such a diversification logic sits comfortably with incumbent firms, it also argues that this approach locks city regions into a rational dependence on existing paths and places. A replication strategy generates an advanced manufacturing transition, but positions sustainability as one component in the reconfiguration mix, rather than as a central part of a systematic sustainable and innovative transition. As Schot (2016) argues, this may lead to transformative change within an existing industry or city region, but it is still aimed at radical optimisation rather than transition of the system. The application of the conceptual framework synthesises how a replication strategy is encouraged by political, cognitive and functional regime constraints which maintain key patterns of path and place-dependence. These patterns are characterised by: attributes that prioritise process innovation over systematic radical innovation; cost reduction responses to sustainability; reliance on existing specialised industries; and mature incremental technological trajectories. Such restrictions deter city regions from initiating alternate directions for regional development; instead they replicate the existing socio-technical regime.

However, whilst replicating the status quo, research findings show that city regions are also implementing supplementary change strategies. In Geelong, supporting intermediaries and firms are pursuing the second diversification strategy – a transplantation and developing an industry transition unrelated to its knowledge base or existing institution expertise. Such a transition involves a shift in regional capability. The process has been triggered by local policy makers and business leaders due to



recent manufacturing closures, job losses and new niche opportunities in manufacturing that offer impetus to diversify the city region. As a result, a clean technology agenda in the form of 'Clean-Tech Innovation Geelong', funding and collaborative local alliances are steering and preparing Geelong for change.

However, whilst transplantation attributes are evident in Geelong, challenges persist, slowing down efforts to stimulate systematic change. These challenges include significant gaps in the city region's current skills base and education and knowledge infrastructure to build future diversification capability. These gaps limit access to external learning networks that open up new market opportunities and multiple competing regional institutional agendas. For reorientation to take place, the concept of 'institutional thickness' proposes that places with *more* rather than *fewer* institutions will prevail (Rainnie and Grobbelaar 2005). However, for Geelong, where an overcrowding of local agencies is inhibiting change, it may be a question of having the *correct* mix of institutions rather than too many or too few. On the other hand, Van Winden et al. (2010) propose that it may not be sufficient to continually foster internal structural change, and that policy makers should instead be attracting global investment and complementary external knowledge in regional locations for long-term transformation. The challenge for Geelong will be to manage these impacting factors in order to sustain city region transplantation efforts to date, and build future growth and resilience capacity.

The empirical evidence demonstrates that a transplantation strategy can also exist at the firm level, independent of a city region's strategic orientation. In Wollongong, where peripheral firms have limited local connections with intermediary actors based within the city region, and are not influenced by place-dependent limitations, unrelated diversification is taking place. This finding disputes contributions put forward by Todtling and Trippel (2005), who suggest that transitions will struggle in places with 'thin' institutional structures. This thinness was a feature for the two Wollongong firms engaging in transplantation, as they had limited physical access to institutions as a result of being located outside the central city region. However, the transplantation strategies of those two firms, 2W and 3W, confirm a study by Berger (2005). Berger argues, that in the absence of intermediary assistance, firms may develop opportunities based on internal capability to mobilise relevant sources of knowledge to construct a competitive advantage for a sustainable and innovative transition.

Geelong combines replication and transplantation attributes for change, whereas in Newcastle and Wollongong a replication and exaptation strategy contributed to new path creation, but did not steer a systematic sustainable and innovative transition. Whilst exaptation, the discovery of new applications for existing knowledge and technology, is more dominant within the Newcastle city region (all eight firms) than Wollongong (four firms), variations in how effectively these attributes translate into a sustainable and innovative transition are displayed in each city region. Newcastle has been somewhat successful in implementing an innovation-oriented adjustment of its steel and mining cluster into higher technological manufacturing platforms, such as electric vehicles, wave technology and energy management. This approach has been supported by a blended subsystem of: internal and external knowledge generation; partnerships driven by multi-national corporation global networks; a local skilled labour force; collaboration with entrepreneurs; and policy and intermediary action. However, although there are emerging signs of change within the city region, Newcastle has been less successful in scaling-up niche-innovations that might generate systematic path renewal. Arguably, this limitation is due to political and cognitive dependent challenges that have historically maintained the status quo and traditional industry structures within the city region.

Wollongong has also pursued an exaptation strategy, but in contrast to Newcastle, it has been less successful in promoting a city region wide adjustment of its traditional manufacturing base. This is due to political, cognitive and functional bottlenecks. Wollongong tends to remain internally focused due to a historical and continuing dependence on the steelworks as a driver for economic growth and jobs. Supporting intermediary actors remain fixated on traditional industry structures to drive growth within the region, and limited efforts have been made to improve weak knowledge infrastructure, external collaborations and path and place-dependent barriers. Rather these attributes have intensified lock-in, causing firms to adopt strategies and partnerships that are driven internally. Although research partnerships are emerging to drive change, subsequent knowledge exchange and extra-regional collaborations are uncommon.

The research findings indicated that the entrepreneurial alliances commonly associated within an exaptation approach occur in both Newcastle and Wollongong. Firms in both city regions sought collaborations with start-up networks to assist with a sustainable and innovative transition. Whilst

incumbent firms experienced challenges in developing sustainability-related niche initiatives, restricted by existing assets and a tendency to react to cost pressures, sustainable entrepreneurs were generally small firms. As such, these firms tended not to be constrained by specific technological mind-sets, were agile and more inclined to experiment. Thus, a sustainable and innovative transition could be triggered by combining these non-traditional alliances (Hockerts and Wüstenhagen 2010).

Drawing more general conclusions from the findings, this chapter demonstrates that the right mix and balance of enabling conditions can stimulate related and unrelated diversification towards systematic change. Despite the fact that a replication strategy denies a truly transformative shift from taking place, it is relatively conflict free, as new activities are linked to existing capabilities and institutions at the city region, national and global level. However, when adopting transplantation and exaptation strategies, tensions surface when the existing regime is challenged; this demonstrates the hurdles which firms and traditional industrial regions face when branching away from secure structures to pursue more innovative alternatives.

Whilst not denying the importance of national, technological and sectoral factors, the findings demonstrate that an analysis of local spatial features is crucial for understanding transition dynamics, institutional change and governance challenges. This is particularly the case in city regions, where intermediary structures play such a large and diversified role in supporting and initiating change. When viewed with an 'a'-spatial lens, transformational characteristics may appear similar but when spatially analysed, prove to be very different. Each city region varies with respect to its industrial specialisation pattern, organisational routines, history, adaptation challenges and knowledge exchange, as well as the role intermediary institutions play in stimulating or restricting a sustainable and innovative transition (Tripl and Otto 2009).

## **5.6. Conclusion**

This chapter has established the importance of understanding the relational, evolutionary and institutional features of a city region to explain how and why transitions take place in different ways in different places. Combining socio-technical system typologies with insights from evolutionary economic geography helps to disentangle the firm from organisational routines and regional institutions and explain the system attributes which support or inhibit a transition region. The research findings

also suggest that future efforts could focus on building the capability of universities and research centres to support business activities in innovative transition fields. This will improve the capacity of learning providers to deliver new and relevant skills, knowledge and networks. Cross-regional collaboration involving the three city regions, engaging firms and intermediaries could be of further benefit. The findings also point to the importance of tackling specific bottlenecks and developing tailor-made regional policy. Such policy initiatives could stimulate networking initiatives across new industries; they can also promote collaborative learning, engagement with entrepreneurs and technologies on a national or international scale. They encourage extra-regional alliances rather than a reliance on a generalised local portfolio.

The transition regions theoretical framework synthesises a systematic identification of the requirements for a sustainable and innovative transition. It has facilitated an analysis of how spatial considerations can be mobilised in attempts to upscale, from niche to regime or exaptation to transplantation, in order to guide a socio-technical regime more intentionally towards sustainable outcomes, and align actors across levels or geographies. The concept of related variety emphasises that effective policy making requires localised action, embedded in and attuned to the specific needs and available resources of city regions. However, unrelated variety and extra-regional collaboration can also be effective in building long term systematic change. Healy and Morgan (2012) argue that without the presence of enabling alliances, developing relevant collaborative governance arrangements (e.g. commercialising knowledge, cultivating clusters, creating supply chains) leading to sustainable economic development, becomes problematic. Reflecting on Cooke (2013), such locations are classified as transition regions - sub-national administrative areas with policies and mechanisms to support sustainable industries, regional innovation processes and integrated clusters of related actors. This chapter exposes the strengths of the city region and weaknesses to be addressed in order to achieve transition region status.

Finally, this chapter has attempted to respond to the call from Boschma et al. (2016) to clarify the extent to which regions specialise in one diversification trajectory over another, and the roles of various actors in stimulating change and tackling conflicts that emerge. Future research is necessary to analyse system diversification attributes in more detail, particularly in terms of how influencing relationships and institutional agendas contribute to spatial evolution. The research also points to the need for closer

analysis of the role and influence of entrepreneurial, multi-national enterprise, customer and cross-regional collaborations, for regional transitions. Chapter 6 further analyses one collaborative alliance not discussed in Chapter 5, which of the role of the customer (original equipment manufacturer) in influencing a shift of the traditional manufacturing firm towards sustainability.

## Chapter 6

### Interfirm customer-supplier collaboration for a sustainable transition

Chapters 4 and 5 have presented an analysis of the socio-technical attributes that stimulate or challenge a sustainable transition of traditional manufacturing firms, industries and city regions within Australia.

Chapter 6 presents the final experiential piece of this thesis by introducing the role of interfirm customer-supplier collaboration in influencing a sustainable transition. For the traditional manufacturing sector, which has a customer base predominantly centred on original equipment manufacturers (OEMs), a systematic socio-technical examination is not complete without considering the ‘demand’ side of the transition equation. Here, an empirical account of the range of attributes which customers look for when collaborating with the manufacturing supply chain is provided.

Following the introduction, section 6.2 provides an overview of the theoretical framework informing this analysis. Section 6.3 presents the methodological approach. Section 6.4 outlines the research findings. Section 6.5 discusses and reflects on these results, informing the conclusion in section 6.6.

The text below has been prepared for submission to the *Supply Chain Management Review* – the Abstract is included in Appendix J. References are incorporated in the combined thesis list and linking comments to Chapter 7 added at the end.

#### 6.1. Introduction

Here the role of the interfirm customer-supplier relationship, in reorienting the traditional manufacturing sector’s production ethos, towards incorporating sustainable alternatives is explored. The importance of understanding this transition dynamic is underlined by the global concentration of production and supplier relationships, which tend to be facilitated by multi-national interfirm partnerships. According to Kiron et al. (2015), almost one-third of the global economy passes through 1000 large companies and associated suppliers. In 2012, the world’s largest 1000 firms generated US\$34 trillion, approximately 40.0 per cent of the world’s \$85 trillion wealth. In the process, these companies ‘influenced billions of people around the world, from employees to suppliers, customers and

regulators' (UNEP Finance Initiative 2014, p.34). If this corporate authority was to be strategically oriented towards attaining global sustainability goals, the conventional production-consumption regime would exhibit significantly less environmental impact than it does today.

The business case for sustainability has steadily grown in importance over the past two decades (Hart and Milstein 2003; Loorbach and Rotmans 2006; Jovane and Westkämper 2009; Qian 2014). More specifically, the concept of sustainable manufacturing has been positioned as not only offering resource savings through production efficiencies, ecologically sensitive design and cleaner production, but also by creating fresh opportunities along the value chain (Qian 2014). Jovane and Westkamper (2009) propose that linking production values with consumption behaviour increases public awareness of environmental pressures and demand for technological and social solutions. This would establish manufacturing as a key enabler of change. While many businesses recognise that financial profitability depends upon establishing a balance across the economic, social and ecological context in which they operate (Kiron et al. 2015), but the incumbent manufacturer (mainly heavy engineering, machining and metals, chemical and steel fabrication sectors), in many instances, struggles to adopt such a perspective (Van Winden et al. 2010). Manufacturing firms that are juggling multiple pressures associated with technological innovation and global competition are, at the same time impacted by climate change, limits to finite resources, and increasingly discerning customers, in terms of product selection or choice. As a shift towards a lower carbon economy becomes more globally accepted and a preferred corporate modus operandi, traditional manufacturing firms are realising that they cannot achieve such a transformation alone.

Sustainability as a concept has evolved, from a simple expression of good intentions and searching for internal operational efficiencies, to a key strategy that addresses critical business issues involving a complex network of strategic relationships and activities across the value chain (Hart and Milstein 2003). A missing perspective within transition research is the role of the consumer in forming relationships for sustainable change. Currently, transition studies focus on understanding the production or supply traits for change; but increasingly apparent within these contributions are new types of consumer-producer combinations, that enable decentralised technology strategies, knowledge diffusion, new business models and transformative reorientation to take place. Through one such

relationship - interfirm customer and supplier - the supplier can, and arguably must, tackle some of the difficult sustainability issues related to production and consumption. Rather than the conventional customer (household end-consumer) market, the manufacturer has a customer base predominantly centred on the original equipment manufacturer. Presently, a four-tiered supply chain system makes up this manufacturing model. Whilst the original equipment manufacturer customer assembles the final product (e.g. wind turbine, solar panel) for the end-consumer marketplace, tier one manufacturing suppliers produce components, such as brackets for solar panels or gear boxes for wind turbines, directly for the original equipment manufacturer. Tier two manufacturing suppliers provide products and services to the customer at the next level in the chain, with tier three and the smaller tier four niche producers delivering specialised components. In the Australian context, Goennemann (2015) argues that these latter two tiers comprise the majority of the manufacturing supply chain but, by contrast currently contribute just 1.0 per cent towards an available 41.0 per cent share of the global manufacturing trade base. By employing collaborative initiatives and innovative sustainable solutions, Goennemann (2015) claims that Australian manufacturing's niche production market share could grow exponentially.

With a focus on the Australian context, this chapter conducts a country analysis that examines the theoretical and practical dimensions for sustainable change across the traditional manufacturing sector. There is an absence of practical and readily accessible information for manufacturing firms on how to develop interfirm customer-supplier partnerships, engage external stakeholders and manage these ongoing relationships to stimulate beneficial innovation and sustainability activity (Wilcox 2016). Published examples illustrate the actions of business conglomerates such as Lotus, which combined high speed and light weight technological expertise to build a sports car. Engineers from Lotus partnered with an aluminum company to acquire knowledge on emerging materials for future automotive vehicle production. The alliance yielded a highly innovative product and renewed capability within Lotus. Similarly, the corporate multi-national firms of Mercedes and Swatch joined forces to develop the Smart Car, while Philips Electronics and Nike partnered to combine digital technology and sporting prowess to design and create niche products and services, to increase sales in the personal training market (Von Stamm 2004). Such case studies demonstrate that the selection of supply chain partners in the creation of sustainable and innovative products is a critical decision factor



in forging successful interfirm customer-supplier alliances. These attributes have not received much attention in the literature.

Chapter 4 identifies challenges and opportunities experienced by incumbent manufacturing firms when undertaking collaboration initiatives. The research findings indicate that longstanding customer collaboration styles 'lock-in' the manufacturer to an existing regime, preventing the firm from searching for sustainable and innovative points of difference. Instead, firms respond to the development of a sustainability agenda through incremental process innovation, such as adopting carbon management systems and corporate social responsibility activities (Hockerts and Wüstenhagen 2010). Further research findings from Chapter 5 illustrate that extra-regional or non-local collaboration attributes contribute to system innovation, subsequently motivating traditional manufacturing firms to explore sustainable business alternatives.

Findings in both Chapters 4 and 5 also suggest that a manufacturing firm's capacity to build innovative and sustainable alliances varies. In Australia, an Ai Group (2016) study of businesses found firms tend to be good problem solvers by exploiting existing knowledge and relationships. However, firms are less willing to collaborate when exploring niche and innovative opportunities, resulting in fewer visionary outputs generated internally. An estimated 45.0 per cent of collaborative relationships were found to be between businesses that already had an established supply chain network. Clearly, many companies turn inwardly to people they already know and trust to help solve problems. The same study illustrated that firms are much more likely to align with each other to develop new products, processes or business models (59.0 per cent of medium-sized business respondents) than with public sector researchers (23.0 per cent). This indicates the importance of united interfirm models as a mechanism for change. Subsequently, this evidence suggests such networks need to extend beyond local and regional boundaries and the importance of building greater interconnectedness within the wider manufacturing innovation ecosystem needs to be considered (Australian Government 2012; Roos 2014; Ai Group 2016).

Enriching manufacturing links both domestically and internationally to maximise the flow and exchange of knowledge, resources and ideas can create greater opportunities for sustainable learning, creativity and ultimately niche-innovation. Kiron et al. (2015) has called for the business community to

join forces to address sustainability challenges, help re-shape the social context in which they operate and explore vital new market sectors. The network of interdependencies among firms, governments and society has created a world of mutual reliance, in which collaboration is a necessary route to stimulate transformative change. This chapter investigates scholarly contributions which indicate that interfirm customer-supplier alliances are critical in generating such relationships for innovative transitions.

This chapter aims to build knowledge, on interfirm customer-supplier approaches to sustainability, in the contextual setting of manufacturing. Drawing on the concepts of technological innovations systems, sustainable collaboration studies and wider industry empirical analysis, this chapter identifies multi-national corporation original equipment manufacturer entities as customers with an Australian-based head-quarters or subsidiary; together with specific manufacturer supplier organisations, these are employed as experiential consumer-production case studies. The research findings demonstrate that maintaining entrenched socio-technical regime behaviours often anchor manufacturers into ‘business as usual’ thinking; making it less likely that they will engage in the notion of sustainability. However, external collaboration (beyond the firm boundary) with ‘new’ customers in emerging markets such as clean technology and sustainability can articulate new demands, provide fresh opportunities for niche manufacturing solutions and influence possibilities for sustainable transitions.

## **6.2. An enriched transitions analysis**

Chapter 3 analysed a socio-technical systems approach towards sustainable transition research in stimulating a change of systems towards environmental and socially sustainable alternatives (Geels 2011). Of particular relevance to analyses of socio-technical systems is the concept of ‘path-dependence’, which is a core feature of evolutionary economic geography studies. The notion of path-dependence emerged from research conducted by Cooke (2013), who explored industrial district transformations in the 1980s and 1990s. This work is now significant in understanding the complex challenges firms face when initiating a sustainable transition. For instance, when firms rely on following a particular path, they tend to optimise existing capital investment scenarios, technology strategies and operating systems that maintain the existing socio-technical regime and ignore future opportunities for new path creation (Boschma et al. 2016). Both Chapters 4 and 5 draw on this

theoretical assessment, to demonstrate the sustainable transition attributes of traditional manufacturing sectors in Australian city regions. Each chapter provides a detailed insight into the transition attributes of 24 manufacturers, systematically analysing the firm context for a reorientation towards achieving a sustainable economy. In recent times, interest has grown in where and how new industries emerge, existing industries adapt (Tödtling and Trippel 2005) and how to steer or coordinate a reconfiguration of the traditional manufacturing sector (Cooke 2013; Gibbs and O'Neill 2014). In spite of this interest, to date the interfirm customer-supplier alliance has been a missing ingredient in comprehending the manufacturing transition dynamic, particularly with regards to the significance of regional and extra-regional interfirm collaborations.

### **6.2.1 Collaborations for sustainability**

Research on collaborations, aimed at improving sustainability outcomes, has historically focused on relations between firms, non-government and government organisations (Niesten et al. 2016). Few studies have addressed customer-supplier collaborations with interfirm or competitor alliances and none have focused on the manufacturing sector (Wassmer, Paquin and Sharma 2014). Several recent contributions have utilised institutional and strategic management theoretical frameworks to explain why firms prefer to collaborate; they consider how institutions influence collaboration and when a choice for alliance building can enhance performance (Niesten et al. 2016; Tether 2002). For example, Kishna et al. (2016) argue that the development of sustainable technologies should be accompanied by organisations *legitimising* technology with the end-user. To achieve this, Fischer and Pascucci (2016) describe new organisational forms of interfirm collaborations that are required for a shift to a more sustainable society. Using empirical evidence from a study in the Dutch textile industry, Fischer and Pascucci (2016) illustrate how supply chain engagement, contract implementation and investment in human and financial resources (*resource investment*) are key organisational strategies that facilitate a sustainable transition. Evidence from Aschemann-Witzel et al. (2016) and Zhu, Feng and Choi (2016), show that sustainable collaboration involves understanding business-to-business relationships and *articulation of demand* features between the business and consumer. Zeng et al. (2016) suggest that institutional pressures embedded in standards and policies such as environmental laws and regulations, are pivotal for developing sustainable supply chain initiatives; but these same pressures can also stymie progress towards achieving transformative sustainability performance (Ramanathan et al. 2016).

These contributions reinforce the important role that collaboration, governance and institutional forms play in facilitating transformative change in different contexts. However, innovation system attributes including knowledge creation, market-niche development, visionary and strategic concepts (Jacobsson and Bergek 2011) or endogenous and exogenous mechanisms for collaboration are less visible.

Tödtling and Trippel (2005) argue that whilst emerging and transitioning industries are influenced by existing dense local knowledge and actor networks, they can also be mobilised by external regional, national and global triggers. Similarly, Asheim and Gertler (2005) claim that if a firm is exposed to very few ‘outside’ contacts, relations become too durable; this may be good for developing trust but a disadvantage for stimulating learning and innovation, resulting in maintaining lock-in and path-dependence. Likewise, Tether (2002) describes the concept of innovation as an interactive and distributed process that involves strategic technological alliances and a range of blended internal and external networks (Freeman 1991). Consequently, firms’ that collaborate with customers in pursuing innovative and sustainable outcomes increase their knowledge of customer needs and improve user confidence in the product-service offerings; this subsequently reduces potential risks associated with bringing an innovation to market. Jensen et al. (2007) describe this mode of firm collaboration as ‘Doing, Using and Interacting’. For interfirm customer-supplier partnerships in the ‘Doing, Using and Interacting’ camp, a transition is about the ‘know-who’ and ‘know-how’ needed at any given point in time. Such attributes are obtained through informal and formal exchanges internal to the firm, but also with suppliers, customers and competitors that share the same practical problems and experiences (Tether 2002). Thus, constant and repeated interaction within such network environments generates the tacit knowledge which responds to user demands and drives innovation within the firm (Jensen et al. 2007). Contrary to what is frequently stressed in the literature regarding clusters and industrial districts (Cooke and Morgan 1998; Boschma et al. 2016), such innovative and collaborative attributes do not seem to be restricted to incremental product innovation. In fact, the likelihood of radical product innovation is 71.0 per cent higher for firms that cooperate with new customers, in a mix of informal and formal interaction (Fitjar and Rodriguez Pose 2013).

Nielsen et al. (2016) call for further research on how resources and transactions in sustainable supply chains differ from those activities in traditional supply chains, which may enable a more thorough understanding of why some forms of collaboration are more effective for a sustainable transition. For

example, Husted and De Sousa-Filho (2016, p.9) suggest that ‘sustainability problems by their nature are complex and different from the products and services with which firms typically deal. Such complexity needs to be matched by more complex forms of collaboration that draw upon resources and capabilities that may live outside the boundaries of the firm’. This chapter makes a critical contribution by demonstrating that conventional and traditional forms of collaboration are unsatisfactory for stimulating a systematic transition and require adjustment to advance sustainable manufacturing and associated supply chain initiatives. Understanding firm socio-technical dynamics is essential in order to identify the opportunities and challenges associated with regional and extra-regional customer-supplier alliances, whether identified by the firms themselves or as initiatives to stimulate change by policymakers. Therefore, an innovation systems analysis is employed here to complement the sustainable collaboration literature, to make a notable contribution.

### **6.2.2 Technological Innovation Systems**

Innovation Systems theory was developed as a policy concept in the mid-1980s for application across different system boundaries including national innovation systems (Freeman 1991), sectoral innovation systems (Malerba 2002), technological innovation systems (Carlsson and Stankiewicz 1991) and regional innovation systems (Cooke, Gomez and Etxebarria 1997). Each construct advocates that the innovation and diffusion process is both a collective and an individual act. In the study of sustainable transitions, such a notion assists in identifying and addressing system strengths and weaknesses for change; not only for developing new products, emerging technologies and markets, but also for building parallel support mechanisms and supply chain capacity (Jacobsson and Bergek 2011).

Whilst each system concept is important, for this analysis a technological innovation system lens assists in defining the characteristics and dynamic disparities of traditional manufacturers attempting to forge alliances with new customers. More specifically, technological innovation systems examine the wider innovation system, including the nature of endogenous and exogenous learning processes and relevant bottlenecks that inhibit production and transition processes. For industry renewal to occur, Bergek et al. (2008) introduce six key resource dimensions as being necessary conditions to support innovation of the system. These include knowledge development and diffusion, entrepreneurial experimentation, resource mobilisation, legitimisation, influences on the direction of search (or incentives/pressures for

organisations to enter the technological field), and new market formation. Drawing upon Jacobsson and Bergek (2011), Truffer and Coenen (2012), Weber and Rohracher (2012) and Binz, Truffer and Coenen (2015), these key elements have been adapted to reveal seven fundamental resource attributes:

- *Knowledge creation* is central to the transition process and a decisive mechanism through which firms create and sustain competitiveness (Binz, Truffer and Coenen 2015). As Jacobsson and Bergek (2011) suggest, whole new value chains often need to be created, requiring that knowledge development and diffusion occurs among a range of firms connected vertically,
- *Market-niche development* is considered a key output of entrepreneurial experimentation, since demand for radically new technologies and products often does not pre-exist but must be created by the actors themselves. For example, the early German solar photovoltaic industry did not begin as a functional global market, rather, technology experts, environmental activists and policymakers aligned to construct a new market segment and lobbied policymakers to regulate the integration of solar into the grid. Once these steps were achieved, the German photovoltaic market materialised (Binz, Truffer and Coenen 2015),
- *Resource investment and mobilisation* of financial and human assets is essential to facilitate adaptation within new manufacturing arenas but can be challenging for actors to obtain,
- *Creating legitimacy* requires an alignment of the new industry and its products with relevant institutional contexts, to obtain social acceptance of change and reduce potential scepticism,
- *Directionality* or the vision created to steer a transition involves implementing institutional elements of change, such as incentive structures, cognitive frames and expectations, and
- *Demand articulation* steers the formation of new markets (Jacobsson and Bergek 2011). Articulating customer demand is required to understand user practices and preferences that shape innovation and transformative change reflected in the socio-technical arrangements of products (Weber and Rohracher 2012).

A missing key resource attribute of technological innovation systems is the identification of policy coordination initiatives (standard settings, codes, laws and regulations) that may be internally introduced by the firm or externally facilitated by government. In the context of transformative change

Weber and Rohrer (2012), in work on system failures of transformative change, illustrate that a parallel analysis of private and public sector policy coordination initiatives needs to be included to understand the transition process. Such an approach ensures coherence between activities of national, regional, sectoral and technological institutions with those of the corporate sector for driving sustainability-related transformation; but this is currently a shortcoming in innovation systems thinking. Hence, a seventh key resource dimension, namely *policy coordination*, is added to complement the conceptual lens.

The main task for an organisation instigating a sustainable transition is to break down the system into these seven key resource components so as to identify potential challenges and opportunities that could hinder or stimulate reorientation of the system. Therefore, a sustainable transition of the traditional manufacturing firm will depend on how the seven technological innovation system functions emerge; as a consequence of systematic interactions and alignment within the interfirm customer-supplier relationship. Binz, Truffer and Coenen (2015) argue that if any technological innovation system features are deficient, the industry in transition will face a significant development barrier. In saying that, critics of technological innovation system theory claim that the conceptual approach focuses more on elements of weakness than on understanding constructive system changes and interfirm dynamics. To address this perceived limitation, this chapter refines a technological innovation system analysis using insights from the sustainable collaboration literature and evidence derived from empirical research. Four interfirm customer-supplier relationships for steering future sustainable transitions are investigated.

### **6.3. Methodology**

Identifying interfirm customer-supplier dynamics for a sustainable transition requires an analysis of actors as well as the social construction of relationships and situations. Table 2.5 (see section 2.3) illustrates the characteristics of original equipment manufacturer customers which were developing a broad range of new products and services, with a focus on clean technology and sustainability market sectors. These customers had established, or were in the process of, selecting and initiating supplier alliances to generate niche opportunities within sustainable value chains. Each customer was extra-regionally located in proximity to its manufacturing supply chain, and internally connected within a

multi-national group structure (see Chapter 2 for details of the methodology). A semi-structured interview was conducted with the relevant manager of each customer. Interviews were designed to explore the seven technological innovation system key resource attributes outlined above (6.2.2), to identify factors that customers determined were key to delivering sustainability-related projects and creating a successful supply chain alliance. All interviews were transcribed verbatim and analysed using qualitative discourse analysis (Foucault 1972). To guarantee anonymity, interviewees are cited in the results section according to abbreviations listed in Table 2.5.

#### 6.4. Role of the interfirm customer-supplier relationship for a sustainable transition

Table 6.1 illustrates that four customers, were actively collaborating with manufacturing suppliers to deliver sustainable value-added outputs, and strategically reconfiguring existing alliances or creating new ones. Another four customers, were seeking to develop new sustainability oriented supply chain collaborations, but had not yet initiated such transition efforts. One customer, (C6) was not pursuing new interfirm customer-supplier relationships, citing that existing global partnerships for supply and manufacture were already meeting corporate expectations.

Table 6.1: Interfirm customer-supplier collaborations

<i>Customer</i>	<i>Functioning 'real-time' collaborations with suppliers</i>	<i>New collaborations being sought</i>	<i>No new collaborations sought</i>
C1	✓		
C2	✓		
C3		✓	
C4	✓		
C5		✓	
C6			✓
C7		✓	
C8		✓	
C9	✓		

The following analysis details the attributes of four functioning interfirm customer-supplier collaborations for a sustainable transition, measured by case study indicators listed in Table 6.2, and supported by further empirical analysis. Table 6.2 defines seven key resource attributes, and describes necessary conditions to support a sustainable transition of the system.



Table 6.2: Interfirm customer-supplier resource alignment across four case study customers (adapted from Binz, Truffer and Coenen (2015))

Key Resource	Formation Process	Definition – activities that...	Case study indicators	Literature Source
<b>Knowledge</b>	Knowledge creation	Create new knowledge & related competencies	No. of R&D projects, collaborative platforms/open innovation, no. of actors involved, learning by doing, key stakeholder/intermediary linkages, tacit knowledge exchange, spatial dynamics	Knowledge development and diffusion....(Bergek et al. 2008)
<b>Market-Niche</b>	Market formation & Innovation	Create protected spaces for new technology, processes and markets.	No. of niche markets, new business models, EPDs, incubators, process & production innovation (incremental/radical), spatial dynamics	Entrepreneurial experimentation....(Bergek et al. 2008)
<b>Resource Investment</b>	Investment mobilisation	Mobilise financial inputs e.g. loans, venture capital	Corporate investment in local initiatives, funding partnerships	Resource mobilisation....(Bergek et al. 2008)
<b>Legitimacy</b>	Technology legitimisation	Embed a new technology in existing institutional structures or adapt the institutional environment to the needs of the technology	Institutional entrepreneurship, corporate investment, lobbying of industry, spin-offs, business case for sustainability, off-shoring V niche value-add	Legitimisation....(Bergek et al. 2008)
<b>Directionality</b>	Vision & goal formation	Create a shared vision for the transformation process	Philosophy for local, shared vision platforms, mind-set, attitude	Influence on the direction of search... (Bergek et al. 2008)
<b>Demand articulation</b>	User need formation	Understand the needs of users for uptake of innovations	Addressing challenges and problems – value add, lean, learning by doing, keeping it local, spatial dynamics	Market formation....(Bergek et al. 2008; Weber and Rohracher 2012)
<b>Policy Coordination</b>	Policy creation	Stimulate change, investment, systematic transformation attributes & barriers	Lack of...agility, policy direction, business case, investment, level playing field, private/public policy More of...internal policy for sustainability	Policy coordination....(Weber and Rohracher 2012)

Note: R&D (Research & Development), EPDs (Environmental Product Declaration).

## Case Study C1

As part of an iconic building and construction project awarded to C1 by the New South Wales (NSW) government, strategic *directionality* was aimed at reducing the development's carbon footprint by 20.0 per cent compared to similar ventures. To achieve this vision, C1 initiated a contractor selection process to identify and engage appropriate suppliers in a formal partnership alliance. Once formed, column four in Table 6.2 shows that these interfirm customer-supplier relationships were nurtured within an open innovation business model and built on sustainability related principles that facilitated innovative *knowledge* creation and capability exchange. As a result of such a 'learning by doing' strategy, alliance suppliers were able to adapt existing products or services or design alternatives to meet the sustainability vision of the customer, and subsequently form a new *market-niche*. For example, one supplier introduced a stewardship service to encourage the return of retired or unwanted goods for recycling, thus creating a value-added component to its existing production line. Following C1 implementing Environmental Product Declarations<sup>20</sup> (internal *policy coordination* program to encourage sustainable supply chain practices), a second supplier conducted a systematic assessment of material content within its plasterboard product. Subsequently, this analysis initiated a series of innovative changes including significantly reducing the volume of raw materials used to create the product. These improvements resulted in creating a lighter, more efficient item and decreased installation time and cost. Consequently, a highly innovative sustainable solution achieved a level of product *legitimacy* and met the *demand articulation* requirements of the end-user by expediting delivery to market. A third supplier applied Environmental Product Declaration policy principles to its carpet manufacturing operation, and, as a result, was able to recognise and remove a toxic substance from the product's configuration -replacing it with recycled ingredients. In addition, C1 established an in-house 'incubator' (a protected space in the factory, away from core business, for experimentation and to work with other stakeholders on innovation and transforming ideas into commercial reality) to explore alternative timber construction techniques and niche experimentation with relevant supplier partners to streamline the building process.

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<sup>20</sup> International accreditation standard enabling a life-cycle and environmental impact assessment of the product to be completed. An Environmental Product Declaration is created and verified in accordance with the international standard ISO 14025 developed by the International Organisation of Standards.

Column five in Table 6.3 illustrates C1 mobilised appropriate *resource investment* attributes to finance projects such as community renewable energy schemes. This unique funding model enabled program contributors to invest in 1KW amounts of solar generation and for the power that was generated, the NSW government would pay a dividend. Such a feature of *demand articulation* motivated suppliers to be more closely aligned with end-consumer needs; this resulted in innovative product design that attained user ‘function’, as opposed to focusing on physical value only. A similar approach was deployed by C1 in a commercial context. In seeking to develop alternative capital investment models for new building ventures, C1 partnered with its supply chain to articulate the views of the client. As a result, C1 was able to design and implement a ‘user pays function’ to supply water rather than owning the physical asset, freeing up resources to be invested in future initiatives. However, longer term corporate *policy coordination* initiatives that stimulated future sustainable building design beyond the awarded NSW project were limited, inhibited by the existing socio-technical regime. Whilst on one hand, reducing the project’s carbon footprint was a pivotal criterion for C1 winning a significant government contract, scaling up the project to achieve internal sustainability-oriented change created challenges, for C1 and its conventional oriented procurement channels. On the other hand, a practical and strategic vision for pursuing sustainability goals enabled C1 to demonstrate the ongoing operational benefits of sustainable product choices and associated supplier innovations.

The introduction of the sustainable supplier alliance is an integrated feature of C1’s value chain, incentivising suppliers to generate in-house sustainability-oriented policies and standards. As a result, this research has shown that suppliers shifted from a ‘cost’ oriented mindset to developing a ‘business case for sustainability’. This shift was motivated by interfirm customer-supplier relationship outcomes and subsequent participation in industry workshops, facilitated by intermediaries such as the Green Building Council of Australia<sup>21</sup>. In contrast to ‘bottom-up’ driven *policy coordination* examples, research findings additionally indicate that government ‘top-down’ instigated policy initiatives tended to place limited value on reducing carbon levels in the building process; this weakened sustainability

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<sup>21</sup> The Green Building Council of Australia was established in 2002 to introduce and drive the adoption of sustainable practices in the Australian property industry. Membership of the organisation represents 600-plus individual companies with a collective annual turnover of more than \$40 billion.

commitment and suggested that C1's awarded NSW project was a 'one-off', rather than a systematic signal of change from the 'top'.

### ***Case Study C2***

Column six in Table 6.3 illustrates that *directionality* and creating a sustainable vision were key resource formation elements, for steering a sustainable transition across all four case study scenarios. These attributes were philosophical features and core elements guiding C2's operational strategy and its corporate sustainable *policy coordination* efforts to increase efficiencies, reduce costs and gain a competitive market edge. For example, to reduce waste in the manufacturing process and compete in globalised production channels, C2 invested in state of the art carpet tile manufacturing technology which was designed to operate within a highly automated, innovative and sustainable manner.

In collaboration with internal multi-national corporation group resources, C2 diffused global *knowledge* across its supply chain. Such partnership arrangements enabled C2 to introduce a new product into an Australian market context. External and internal corporate experts specialising in lean manufacturing<sup>22</sup> and biomimicry<sup>23</sup> techniques, operated within an open innovation framework to engage suppliers, imparting *knowledge*, solving problems and generating value added innovation as part of the company's transformative journey. However, not all suppliers benefitted from such an approach. The research indicates that one supplier's reluctance to explore recycling solutions for example, prompted C2 to terminate the partnership and collaborate with an alternate supplier in order to achieve its sustainability goals. This particular interfirm customer-supplier challenge triggered C2 to consider mentoring other suppliers in how to adopt sustainable practices, beyond its own supply chain pool:

*Do we start acquiring other companies and make them more sustainable?....go beyond our own boundaries and influence and reduce impact elsewhere C2.*

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<sup>22</sup> Systematic method for the elimination of waste within a manufacturing system (Krafcik 1988).

<sup>23</sup> From the term 'bios', meaning life, and 'mimesis', meaning to imitate - a discipline that studies nature's best ideas and then imitates these designs and processes to solve human problems; studying a leaf to invent a better solar cell is an example (Benyus 1997).

Such sustainable *directionality* attributes stimulated internal *resource investment* within the multi-national corporation group structure, built upon the founder's corporate sustainability principles which are shared by employees and suppliers alike.

In addition, external *policy coordination* activities, such as those facilitated by the Building Education Revolution<sup>24</sup> program, stimulated new interfirm customer-supplier innovations to measure and reduce building inefficiencies. Consequently, C2 introduced a recycled product, replacing a fossil-fuel based option with a superior, eco-friendly building material alternative and established a *market-niche*. At the same time, C2 implemented a technology road map that delivered the first 're-entry' facility<sup>25</sup> to an Australian market. This technology enabled a niche product to be scaled up by recycling large volumes of carpet on-site rather than off-shoring the process. Existing suppliers were encouraged to increase the content of recycled materials within their product, thus C2's influence was leveraged for reduced manufacturing environmental pressures and impact. However, whilst the Building Education Revolution government *policy coordination* program stimulated a niche in the market, research indicates that C2 is continuing its efforts to advocate for further state and local government intervention to accelerate the business case for sustainability, particularly in relation to re-use and recycling of waste products. For instance, to increase the amount of recycled content in building construction products, C2 called for such criteria to be stipulated in local government development applications and for landfill fees to be increased. However, such policies are yet to eventuate.

Corporate *policy coordination* initiatives involved the implementation of a standardised certification process to ensure environmental and sustainable obligations were met internally, creating product and firm *legitimacy* and end-user reassurance:

*Certification is our business... ..we have a program to remove all substances and emissions...so we are down to 0.1% of some compounds as our process has removed them...the architects that we deal with are aware of that...C2.*

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<sup>24</sup> An Australian government program designed to provide new and refurbished infrastructure to eligible Australian schools. The program was part of the Rudd government's economic stimulus package in response to the 2007–2010 global financial crisis.

<sup>25</sup> Technology that separates old carpet tiles into face cloth and backing, and sends the face materials to other companies for recycling. The proprietary technology can turn the old backing into new backing and convert the separated backing into pellets.

Building corporate legitimacy was also accomplished by participating and presenting at relevant conferences and universities. These presentations complemented factory tours conducted by C2 to showcase its sustainability and advanced manufacturing credentials; key points of difference and value creation attributes for the organisation. Such strategic collaboration initiatives to ascertain user *demand articulation* attributes were key to customising product and reducing waste, at the same time benefitting key suppliers with access to new *knowledge*.

### ***Case Study C4***

For C4, generating skills and knowledge in engineering procurement and construction techniques for designing large scale solar projects in remote locations, were key *resource investment* attributes for building and strengthening the supplier capability base. When managing projects around the world, C4 organised supplier engagement forums to clearly articulate a project's *directionality* and vision, and in the process identify and recruit appropriate suppliers. For example, in executing an Australian renewables contract C4, assisted by supporting intermediary organisations, selected suppliers with the capability to streamline product design, manufacture and installation in order to meet the logistic and timeframe challenges of building in remote locations. C4 sought appropriate and capable suppliers who could contribute to solving such complexities through value adding, experimentation, innovation and agile practices:

*I had to do a roadshow...if you mention solar they think 'you put something on your roof and you get hot water', no. So I actually had to go down and do a full presentation to them and show them what we were about C4.*

Hence, undertaking supplier selection was a critical and *directional* exercise in securing the sustainable positioning of C4. New interfirm customer-supplier alliances were established with traditional engineering and technical manufacturing suppliers, who had not previously been involved in sustainability or clean-technology related projects, but which had the demand attributes and formation processes for adaptation and innovation. Such collaborative exchange facilitated *legitimacy* and dissemination of sustainable product knowledge, while complementing a typical non-traditional area for the manufacturing supplier and establishment of a new *market-niche* for C4, applicable to global like-minded projects. For instance, C4 developed a niche solar photovoltaic module to replace diesel power

generation in remote mining locations. By applying the supplier's engineering and technical expertise, the solar components were produced and installed using modular design techniques, enabling C4 to create a unique barcode for each individual asset. Consequently, the product was able to be monitored and identified in any location, allowing C4 to collect, re-use or recycle modules at the end of their life, generating a *legitimate* and unique corporate product stewardship framework for the solar industry as well as meeting its own corporate sustainability goals.

Financial *resource investment* for solar projects in Australia was primarily mobilised by corporate ventures and external funding, while project developers aligned with suppliers, energy utilities and relevant levels of government to manage the project. Two large scale projects in remote Australia were developed by C4 in this manner. For example, by employing innovative and agile manufacturing suppliers to develop unique modular components, C4 was able to manage rigorous construction timeframes, stagger financial payments and enable space for innovation to occur throughout the project and not just at the design phase. Such initiatives met the client's *demand articulation* goals which would have proven problematic if the product was pre-manufactured and shipped from overseas. It would have been subsequently exposed to risks of time delays, logistical complexity and rigidities that constrain innovation. As a global company, external *policy coordination* programs that prioritise a percentage of local content in manufacturing negotiations, provides certainty for projecting the costs, labour and skills required for each job. However, in Australia, such policy conditions are rarely a requirement in contractual tenders. The research suggests that such unequal global trading circumstances, illustrated in column four in Table 6.2, disadvantage Australian industry from acquiring and scaling up clean technology manufacturing capability to compete on a global stage unless customers, as in the case of C4, strategically seek these collaborative relationships with suppliers on the ground.

### ***Case Study C9***

The development of an open innovation platform was a key manufacturing supplier collaboration strategy for C9, and is illustrated in column two of Table 6.3. Such a mechanism was designed to create and facilitate *knowledge* exchange in partnership with relevant suppliers, to develop the best possible technological solutions. Embedding innovative principles within corporate *directionality* and

vision enabled C9's multi-national corporation research and development heads to collaborate with smaller suppliers through internal network channels. In turn, regional knowledge spillover triggered a renewed trajectory across the local supplier base. The research suggested that such interactive learning alliances generated a *legitimate* innovative manufacturing system that attracted external experts to work with the customer and supplier; this further extended and built upon existing regional knowledge foundations. As a result, C9 established sustainable *market-niches* in downstream businesses. For example, a manager from C9 described: *a solar thermal roofing system that combines solar heating and cooling with photovoltaic electricity production, ventilation and fresh looking aesthetics* as one new market opportunity. To strengthen product *legitimacy*, C9 consulted customers beyond the immediate tier two and three levels to gauge an understanding of *demand articulation* influences within the market. Based on such consultation initiatives, C9 engaged with appropriate suppliers and stakeholders, legitimising the product and process to build alliances to meet future customer demand. Additionally, C9 complemented internal *resource investment* activities, of research and product innovation, by collaborating in a number of external university research partnerships; these included those funded by the Australian Research Council for example, to explore future technology applications.

Column eight in Table 6.3 illustrates external government *policy coordination* initiatives, to support Australian manufacturing or sustainability programs, was lacking and posed a significant challenge for C9 in pursuing its transition in Australia. As a subsidiary site within a multi-national corporation competing in a global marketplace, such policy foresight is a requirement for developing future sustainable markets:

*I think it is noble to say that Australia needs to stand on its own two feet and for us to try and survive, this would be the right stance if it was a level playing field. I know businesses that we compete with in China who get free land, interest free loans, subsidies and enormous help...the government is good in changing policy regulation to create less red tape for us...but until we get our heads around the cost of doing business in Australia...it is going to be very difficult C9.*



## 6.5. Discussion

This chapter has combined the key features of Technological Innovation Systems with insights from the transformative failure perspective within innovation systems and sustainable collaboration literature, to identify the interfirm customer-supplier attributes of a sustainable transition across four manufacturing case studies. Previous literary contributions have identified that a lack of understanding exists in how sustainable supply chains emerge or differ from traditional models (Niesten et al. 2016). Hence, this conceptual frame enables a systematic analysis of the key features that influence and determine how the manufacturing supplier can innovate and adapt a process or product to meet the customer's sustainability vision; in the process this stimulates a sustainable internal reconfiguration beyond the firm's traditional production roots.

Table 6.3 summarises the sustainable transition attributes in the four observed case studies. Five key findings derived from these results, confirm the importance of the seven combined key resource alignment features for a sustainable transition. First, Table 6.3 uncovers the relevance of extra-regional and regional proximity attributes for stimulating a transition. In all four case studies extra-regional customer collaboration introduced new resource formation attributes creating key building blocks for change. These were then aligned to endogenous regional path creation across the supply chain (Binz, Truffer and Coenen 2015). Many traditional manufacturers are part of small and self-contained city regions and excessive cognitive or organised proximity amongst local suppliers can be detrimental to a transition, leading to lock-in and limiting innovation. Furthermore, the research indicates that manufacturers who engage in extra-regional, novel customer collaboration tend to increase the uptake of innovative opportunities, compared to firms that rely on internal resources or existing customer interactions for innovation. Hence, the heterogeneity and extra-regionality among interfirm customer-suppliers adds *legitimacy* and *directionality* to innovative relations setting them apart from others.

Table 6.3 also illustrates that most resource formation processes were retained and aligned in a regional yet internationally well-connected innovation system formed around a global technology (e.g. modular design of solar systems, re-entry recycling facility), as a result of internal multi-national corporation relationship subsidiary structures. Binz, Truffer and Coenen (2015) argue that possessing a range of mobilising attributes to stimulate a transition contradicts Crevoisier and Jeannerat (2009), who suggest that *knowledge* is the only anchoring resource formation process. Whilst knowledge creation is

important, Tether (2002) claims that ‘group firms’ are able to internally draw upon other resource qualities such as *legitimacy*, market access, *investment*, power, *demand articulation*, security, and the branding and prestige of a global reputation in seeking partners for innovation. Leveraging these processes enables a supplier to access a variety of resources beyond knowledge, which is a key research finding in all four case studies.

Second, Table 6.3 articulates each customer’s sustainable vision and *directionality* attributes. Kiron et al. (2015) claim that firms which prioritise a sustainability agenda are more than twice as likely to pursue collaborations that are strategic and transformational, the current research supports the analysis of Kiron et al. (2015). Promoting sustainability strategies enables each customer to identify and engage with like-minded suppliers and partners to achieve its goals, and presents a compelling case for organisational change and business model innovation. As a result, the presence of robust sustainability principles and integrity embedded in each case study customer’s operations consequently influenced a supply chain reconfiguration. Subsequently, if a vision for sustainability was activated, all other key resource formation processes were mobilised. When both sustainability-oriented collaboration and business model change occur, the combination is strongly correlated with sustainability-based profits and new market creation.

Third, echoing contributions within the ‘Doing, Using and Interacting’ literature, Table 6.3 illustrates each interfirm customer-supplier relationship was formed within a model of open-innovation, demonstrating that ‘learning by doing’ attributes are an essential ingredient for a transition. In a survey of 1604 Norwegian firms, Fitjar and Rodríguez-Pose (2013) found that innovation tended to develop in open collaborative environments, by drawing innovative capacity from a mix of internal and external interaction. The imported sustainability *knowledge* and know-how obtained and exchanged from within the customer multi-national corporation group structure, presented new learning opportunities for the supplier, and transformed the incumbent firm in a localised ‘learning by doing’ process. Jensen et al. (2007) suggest that ‘Doing, Using and Interacting’ type collaborations involve more transmission of tacit knowledge and practical know-how, which is less easily transferred across geographical distance. Such a claim may explain the success of the open innovation model analysed in this chapter. However, in contrast, when mapping extra-regional supplier relationships across the four research case

studies, collaboration was associated with a high degree of sustainable product innovation regardless of spatial proximity. Each customer employed a mix of regional and extra-regional suppliers and therefore, was indifferent about the need to be geographically proximate, citing a preference to appoint a supplier that met the needs of the customer rather than whether they were locally based. This indicates that customers favoured cognitive proximity over geographic proximity. Thus, system building dynamics on the customer side (with differing, yet related market ‘clean technology’ segments), together with pre-existing competence in designing and manufacturing related technologies (fabrication, machining, engineering and technical expertise) were crucial factors to the interfirm partnership and success of the supplier transition, integrated within a ‘learning by doing’ and open innovation framework.

Fourth, Teece (2010) argues that for innovation to occur, a wide variety of assets and competencies need to be accessed, which are unlikely to be provided by one company. To produce a personal computer for example, a company needs access to multiple levels of expertise in developing semi-conductor and display technologies, disk drive, networking and keyboard technology and many other areas usually enabled by aligning with relevant third parties. This chapter demonstrates the value of involving suppliers in the product development journey, including understanding aspects such as time to market, competitive positioning, quality control, costing estimates and process efficiencies; rather than each stakeholder working independently to introduce a new product.

Table 6.3: Summary of key interfirm customer-supplier functions & attributes for a sustainable transition (adapted from Binz, Truffer and Coenen 2015)

		<b>Knowledge</b>	<b>Market-Niche</b>	<b>Legitimacy</b>	<b>Resource Investment</b>	<b>Directionality</b>	<b>Demand Articulation</b>	<b>Policy Coordination</b>
<b>C1</b>	Extra-regional	Open-innovation platform for collaboration & external knowledge exchange	EPDs implemented, Incubator	State government awarded sustainable build	Internal investment within the global 'group'			Preference for sustainable design but limited general policy for scaling-up
	Regional	Learning by doing to adapt products & services	Process, product & business model innovation	Supplier alliance developed	Community & corporate funded projects	Carbon reductions for regional build, business case for sustainability	Deliver the 'function' instead of the technology	Challenges scaling up corporate sustainability principles
<b>C2</b>	Extra-regional	External knowledge shared across the global group & diffused, open innovation framework	Technological innovation stimulates market shift	Sustainability reputation & credentials – unique selling point, certification process	Internal investment within the global 'group', tax incentives	Sustainability is key to production and part of core vision	Front end design process	National economic stimulus triggered innovation, sustainability criteria in development approvals
	Regional	Learning by doing to problem solve & value-add	Downstream influence for recycled content, business model innovation	Suppliers leverage off credibility, present at conferences/schools to educate stakeholders		Business case for sustainability built within supply chain	Supply chain integration	Process innovation, increase landfill and regulatory fees
<b>C4</b>	Extra-regional	External engineering construction knowledge procured within group	Niche process innovation for installation	Formal supplier process critical to development strategy	Internal global investment, partnership funding	Policy to build domestic capability base	Process innovation to meet customer demand	'Local content' requested around the world, unequal for Aus.
	Regional	Intermediary know-how selected suppliers	Modular design and manufacture, product stewardship	Related expertise led to supplier alliance		Forms to impart knowledge/direction, value add via sustainability		Cost of doing business, regulations, globalisation
<b>C9</b>	Extra-regional	Open-innovation model – global & local experts	Downstream niche innovation		Internal investment, global research partnerships	'Sustainability' = smart product design for the customer = business case		
	Regional	Innovation Council & local interactive learning & knowledge spill-over	Business model innovation	Company managers & system intermediaries present to stakeholders in product & process		Business case for sustainability	Work along value-chain to understand customer	Unequal playing field, cost of doing business, regulations, globalisation

Tether (2002) insists that innovation is becoming increasingly distributed, as fewer firms are able to ‘go it alone’ in technology development. This results in a transition to more sustainable production, due to alignment with external industry partners. Mobilising a range of stakeholders, imported knowledge and resources from other places enabled new *market-niches* to be formed across each case study observed (Table 6.3), subsequently encouraging technological development, new business model formations and other associated change. Where creativity and entrepreneurial enterprise was limited across the case studies, a collaborative environment for experimentation opened up a ‘protected space’ for innovative activity and trialing of niche initiatives for both the customer and supplier (Loorbach 2010). Such a strategy assisted both customer and supplier firms to *articulate the demand* of future end users, leverage resources, share risk, build new capability, compete globally and create *legitimate sustainable markets-niches*.

Fifth, Table 6.3 demonstrates that public and private *policy coordination* and government intervention is seen as both a key ingredient and detriment to a sustainable transition (Binz, Truffer and Coenen 2015). On one hand, in-house corporate policy instruments (e.g. contracts, standards and disclosures) as well as external regulations that support sustainable projects, stimulate the market and foster *market-niche* development. Structural mechanisms such as certification were used, not only to *legitimise* sustainability initiatives but also to ensure transparent and accountable practices were incorporated; these were crucial to building a business case for sustainability and mobilising necessary *resource investment*. On the other hand, inconsistent and confusing public policy statements inhibited transformative change for the customer and supplier which, in turn, limited scaling up of niche innovations, *resource investment* strategies and capability building opportunities. This research suggests that although Australian government policy initiatives lack clarity for guiding future sustainability and manufacturing industry change, the market is able to find a way to internally reconfigure by employing innovative, collaborative solutions. So, internal corporate sustainability *policy coordination* was key to driving a sustainable transition.

Drawing more general conclusions from this research, selecting and appointing suppliers for involvement in sustainable product development was a significant decision factor in forging interfirm customer-supplier alliances, but has not received much attention in the literature. Wagner (2010) points

out that the degree to which a supplier's sustainable business ethos complements the customer's business culture, is an important collaboration characteristic. Whilst internal knowledge creation, technology development and manufacturing expertise are important, other factors considered critical in the selection process included: a supplier's competence and innovation mindset combined with the qualities of trustworthiness; reliability; openness; mutual support and goal congruence. Such an implicit contribution counters the suggestion in the literature, that interaction simply happens because 'something is in the air' or as a result of 'being there' or sharing the same geographical location (Gertler 1995).

Whilst the transition literature emphasises the role of path-dependency as a factor that can inhibit the transition process for incumbent manufacturing firms, this research illustrates that forming interfirm customer-supplier alliances contribute to the types of system shifts required to overcome such a reliance mind-set. In turn, the partnership generates benefits for both actors, particularly in the shape of encouraging risk taking, entering new markets, engaging in cognitive learning settings and opening up space for innovation (Tether 2002).

This chapter has demonstrated limitations within both the technological innovation systems and sustainable collaboration literature. The technological innovation system concept on innovating systems does little to assist in understanding the role of firm collaboration activity, particularly interfirm or customer-supplier alliances and the role of public or private policy initiatives to stimulate sustainable change. As a result, the typology's prime motivation has been on analysing firm technological approaches which overlook interaction with other system environments (Jacobson and Bergek 2011) and do not fully tackle the problem of transformative change in existing socio-technical regime. Whilst the sustainable collaboration literature places emphasis on individual elements of the system, or incremental approaches for transformation, it too lacks a holistic overview of systematic innovation for a sustainable transition (Niesten et al. 2016). Interposing a technological innovation systems framework more systematically with a sustainable collaboration lens responds to filling these gaps and provides an explanation for this phenomena in a way which has yet to be theoretically and practically articulated.

## 6.6. Conclusion

Chapter 6 demonstrates that both knowledge and market-niche creation are important attributes to stimulate an interfirm customer-supplier sustainable transition. But it also shows that each of the seven features of the combined technological innovation system and sustainable collaboration framework are needed, to develop a successful collaborative environment and a systematic sustainable pathway. Each of the factors Binz, Truffer and Coenen (2015) identified helps to explain the variables of path creation, beyond firm-based organisational routines and traditional production mind-sets. These attributes include: the disentangling of actor networks and institutional contexts of knowledge creation, market-niche formation, legitimisation, mobilisation of financial and resource investment, vision and direction setting, articulation of demand and the transformative nature of policy coordination initiatives.

The conceptual framework contributes towards developing a more nuanced response to the question of whether sustainability based interfirm customer-supplier alliances stimulate a transition of the traditional manufacturer. It is also demonstrated that new and adapting industries depend on the co-evolution of both proximate and socio-technical embedded innovation processes as well as extra-regional alliances within the global innovation system to stimulate change. In terms of wider implications for sustainable transitions, this work contributes to the understudied topic of the role of incumbent firms and regime-level actors in transition processes (Geels, Tyfield and Urry 2014). Whilst much of the literature focuses on the role of institutional factors that inhibit sustainable transitions of incumbent manufacturing firms, this chapter demonstrates the equally important role that interfirm and collaborative relations have on influencing systematic change. Such findings signal the value of paying attention to the role of collaboration in order to understand the development of future manufacturing sector transitions. Further research could apply the conceptual framework described in this chapter to a wider range of manufacturing firm contexts or other traditional industries. Ongoing research could also examine confounding case studies that display less collaborative environments, in pursuit of systematic transitions, in the manufacturing sector. In addition, the transformative failure perspective on innovation systems in this chapter considers the impact of denying a true understanding of the demand articulation and policy coordination attributes of the end user market; it only goes so far in identifying the end-user consumer-producer relationship. A perspective missing from transitions research is not

only that of the original equipment manufacturer customer in a consumer-producer type combination, but also in extending that of the end-user consumer-producer analysis.

These considerations, of the role of interfirm customer-supplier collaborations in the transitioning process, conclude the current research and lead on to the synthesis of findings in the next chapter.



## Chapter 7 – Discussion and Conclusions

The concluding chapter of this thesis combines the theoretical and practical research findings, included in Chapters 3 to 6, to discuss the key research aim introduced in Chapter 1 that was to: *identify the attributes of a sustainable transition for the traditional manufacturing industry sector in regions of Australia.*

As previously acknowledged, developed economies are currently facing fundamental sustainability challenges in several realms. One pivotal domain, the traditional manufacturing sector, is particularly impacted, confronted by shifting production patterns and outputs as a result of climate change, as well as environmental degradation and limits to resources. These challenges are coupled with, and threatened by, a range of path dependent and lock-in characteristics that are synonymous with conventional operations of manufacturing firms and industrial locations. Whilst these complex issues have been recognised by many governments, industry organisations, scholars and the firms themselves, there is limited evidence of actual on-the-ground sustainable transitions taking place. Hence, relevant actors and intermediaries find it difficult to identify factors that could contribute to successful, practical or long-lasting change centred on traditional manufacturing. Regional studies and economic geography scholars (Cooke 2009, Gibson, Carr and Warren 2012 and Gibbs and O'Neill 2014), actually state that techniques to identify the attributes of successful transitions are missing.

Despite the growth in research seeking to develop alternative economic approaches to address weakening industrial sectors (Cooke 2009; Trippl and Otto 2009; Van Winden et al. 2010), regional renewal (Tödtling and Trippl 2005; Gibbs and O'Neill 2014) and manage a reorientation towards a sustainable future (Geels 2002; Loorbach 2010), transition scholars recognise that these contributions are positioned at the cross roads of four avenues of change illustrated in Table 7.1. Here, Gibbs and O'Neill (2014) emphasise that existing business as usual, system adjustment and technological strategies employed to enable the transition process are not working to shift the status quo. As a consequence, the established manufacturing socio-technical system undergoes incremental rather than

radical change. But slow incremental change will not suffice to tackle future sustainability oriented challenges (Markard, Raven and Truffer 2012).

Table 7.1: Four transition avenues of change (adapted from Gibbs and O'Neill 2014)

Business as Usual	System Adjustment	Techno-stability	Sustainable Transition
<ul style="list-style-type: none"> <li>• Continued growth</li> <li>• Emphasis on fossil fuels</li> </ul>	<ul style="list-style-type: none"> <li>• No leadership on climate change or reducing fossil fuels</li> <li>• Power black-outs increasing/</li> <li>• Energy Crash</li> <li>• Social fragmentation</li> </ul>	<ul style="list-style-type: none"> <li>• Low carbon shift through expansion of green technologies</li> </ul>	<ul style="list-style-type: none"> <li>• Creation of resilient society</li> <li>• Climate change adaptation</li> <li>• Renewable energy</li> <li>• Living within ecological limits of growth</li> </ul>

Nevertheless, whilst pursuit of a sustainable economy poses challenges, it also affords opportunities to create a new trajectory illustrated in column four of Table 7.1. Furthermore, this thesis demonstrates that an interdisciplinary transition model can identify the influences of sustainable change and interactions between diverse actor groups within the manufacturing sector. It addresses a number of limitations within the transition, geography and regional studies literature, by systematically embedding manufacturing and sustainability across multiple scales of place. Of equal importance is the contribution this thesis makes to combining science and practice, through the design of theoretical frameworks and constructs, which can be practically and empirically applied, particularly within a policy context. Recent policy research indicates the urgent need to develop climate economy frameworks that provide the tools and initiatives to steer a global transition (The Global Commission on the Economy and Climate 2014). However, this top-down driven call for action does little to interpret the system transition attributes of traditional manufacturing regions, or to position such research within mainstream management, policy and strategic planning domains.

This research firstly establishes the missing links for a holistic transition approach and then builds a unique interdisciplinary theoretical framework to enable the identification of sustainable transition features within and across the traditional manufacturing arena. In the preceding chapters (3 to 6), the framework is developed and the hypothesis tested, by analysing the contributing factors that influence a sustainable transition in the socio-technical spectrum of 24 manufacturing firms across three city

regions in Australia. More specifically, each chapter provides an insight into the disruptive consequences and implications that exist within incumbent manufacturing systems and offers a vision of what is possible when resistance to system change is reduced (Geels, Tyfield and Urry 2014). Much of the research to date has been undertaken mainly in Europe, where system conditions differ considerably from Australia or other developed economies. So, this thesis provides an Australian perspective on sustainable transitions in traditional manufacturing regions. A systems-based, socio-technical analysis is conducted across four dimensions, including the manufacturing firm, industry sector, city region and customer-supplier alliance. In the process, sustainable transition theory is refined to reflect diverse country, institutional and political settings.

### **Identifying attributes of a sustainable transition for traditional manufacturing – a conceptual framework**

The transition literature is limited in capturing the opportunities a developing sustainable economy brings for regenerating the manufacturing sector. Consequently, this thesis reviews and integrates four existing interdisciplinary concepts, to identify the existing and emerging attributes of a sustainable transition for traditional, regional manufacturing industry sectors. Chapter 3 provides a detailed review of each of the four concepts which forms the ‘Attributes of a Sustainable Transition’ theoretical framework. These notions include: Advanced Manufacturing (Green and Roos 2012; Roos et al. 2014; Wilcox 2016); Sustainability Transitions (Kemp 1998; Geels 2002; Geels and Schot 2007; Markard, Raven and Truffer 2010; Lachman 2013); Regions are Spatial (Massey 1979; Hudson 1999; Cochrane 2012; Gibson, Carr and Warren 2012); and Transition Regions (Enright and Roberts 2001; Cooke 2009; Horwitch and Mulloth 2010; Amison and Bailey 2014; Gibbs and O’Neill 2014).

The *advanced manufacturing* approach theorises shifting a conventional high volume, low cost physical production paradigm towards adopting non-technological attributes. These include higher value added manufacturing, customisation, innovative skill sets and collaborative, knowledge driven networks that generate new learning environments and diversify market share. However, an advanced manufacturing model is deficient in exploring the core values of sustainability for manufacturing firms as well as their application within a spatial context. For instance, according to Massey (1979), it is not just the industry that matters, but rather the mix in those industries and the willingness of individual firms to embrace

change at a variety of intersecting levels. Massey (1979) articulates that if the development of renewed pathways are to succeed, industry and regional actors need contemporary techniques as well as product accumulation for transformation. The *sustainable transition* approach, broadens the advanced manufacturing model to address such transformative limitations. A lens that uses the multi-level perspective and transition management as well as technological innovation system typologies, enables repositioning of the sector by adopting sustainable governance, technology and practices that present opportunities for diversification. By applying insights from sustainable transition theory, organisational regime characteristics that resemble lock-in of the manufacturing system are empirically highlighted and challenged (Markard, Geels and Loorbach 2010); this provides a new dimension of study and application within a complex industry sector.

To date, the sustainable transition approach has received limited application in manufacturing firms, which are predominantly concentrated in regional areas and on the outskirts of capital cities. As a result, an understanding of *regions within their spatial context*, is an essential feature of the Attributes of a Sustainable Transition theoretical framework to appreciate characteristics distinguishing regions and places. Such an analysis is particularly relevant in Australia, where geographic size, socio-cultural settings, institutional, political and macro-economic challenges are different to most European industrialised countries. A number of leading transition scholars, such as Cooke (2009), Coenen, Raven and Verbong (2010), Markard, Raven and Truffer (2012) and Hodson and Marvin (2012) as well as geography scholars including Gibbs (1998), Hudson (2002), Hicks (2014) and Gibson (2013) claim that transition theory currently lacks a spatial analysis, particularly at the regional level (Cooke 2009). The incorporation of a spatial lens deepens the empirical basis for sustainable transitions. It also strengthens the Attributes of a Sustainable Transition theoretical framework in addressing questions concerning how and why particular transition arenas perform differently in various geographical settings. In addition, it acknowledges the call from Coenen, Raven and Verbong (2010, p.296) for ‘translating success to localities and upscaling into mainstream regime practice’.

Whilst sustainable transition research has increased dramatically over the last decade, it has been dominated by transition specialists, and regional studies scholars and geographers have been less prominent in the field (Markard, Raven and Truffer 2012; Hansen and Coenen 2015). As a

consequence, transition research has been largely positioned within innovation and research policy journals and not reaching wider audiences. Geography specialists have advocated that a broader spatial conversation needs to take place, particularly for re-shaping regional development policy. According to Gibson (2013, p.3), the transition policy debate must acknowledge the regional foundations of the manufacturing sector:

‘Attempts to alleviate regional impacts of manufacturing contraction in the Illawarra have had limited success. Governments have thrown money at the problem too quickly without a good evidence base for what might work. Retraining and job placement schemes have operated without broader strategic regional development, infrastructure and industry support’.

The final building block in the Attributes of a Sustainable Transition theoretical framework, includes the concept *transition regions*. Drawing on geographic inquiry, a transition regions approach explains dimensions of the path-dependent, related variety and proximity attributes of a manufacturing region. Within this model, a focus on knowledge, capabilities, expertise, place narrative and relational connections helps understand how to establish resilient industries with communities that can contribute to building a sustainable economic future.

The Attributes of a Sustainable Transition theoretical framework addresses a knowledge gap, because applied singularly, each of the four conceptual approaches examined is limited in its scope to detect features of a transition in the manufacturing context of Australia. Yet, integrated and adapted within a systematic framework, each concept complements the other; identifying new knowledge, interconnections, similarities and differences towards interpreting the emerging attributes of a sustainable transition. Chapters 4 to 6 in this thesis, test this research hypothesis through empirical application in Australia.

### **Insights into a sustainable transition of the traditional manufacturing firm and sector**

Chapter 4 empirically applies the first part of the Attributes of a Sustainable Transition theoretical framework to investigate attributes of a sustainable transition for a traditional manufacturing firm. By combining advanced manufacturing and the multi-level perspective as well as transition management concepts, the framework enables an analysis of transition attributes at the firm and sector level to be

conducted (see Figure 4.3). Subsequently, Chapter 4 also addresses a number of limitations in both conceptual domains for integrating sustainability and manufacturing.

Rather than concentrating on the physical production side of manufacturing, an *advanced manufacturing* approach enables the sector to encompass the whole chain of production activity from research and development to end of life management. This notion opens up opportunities to improve and develop productivity levels, skills, value-added features and new markets. A socio-technical analysis of the manufacturing sector requires new environmental problems to be investigated at the social as well as the technical level, and to consider the existing system as well as the societal domain in which an organisation operates. Loorbach and Wijsman (2013) suggest the transition literature on firm change has revealed important insights into how business might engage with sustainable transition theory and relate this to internal business transitions. Yet such vision, to date, has not been detected in the traditional manufacturing sector. At the same time, the concept of advanced manufacturing is facilitating innovative and technological change across the sector and associated networks, but is yet to operationalise essential non-technological characteristics (Roos et al. 2014), to steer socio-technical change in Australian regions. Thus, a *sustainable transition* approach combines key heuristic typologies including the multi-level perspective and transition management to achieve such an inquiry. In combining the two approaches, Chapter 4 presents key findings of a systematic socio-technical analysis of 24 manufacturing firms in three Australian city regions. The investigation illustrates new dimensions and institutional insights into an industry sector which is preparing itself for a changing social, economic and environmental future. This study emphasises the individual and collective operational choices and practices of firms in traditional manufacturing settings. The findings show that whilst eight firms resist transition, 16 are accelerating a transition pathway and six of these are engaging in new sustainable path reconfiguration activities. Such transformative diversity is influenced by three dynamics of change, including landscape pressures, socio-technical regime factors and niche-innovations.

Table 7.2 illustrates that complex landscape pressures including, globalisation, climate change, technological development and socio-technical regime factors specifically impact a transition of the manufacturing sector. In Australia, these challenges are exacerbated by industrial and political rhetoric

and policy confusion, which impacts the strategic choices of firms and discourages a commitment towards sustainability.

Table 7.2: Challenges impacting a manufacturing 'firm' transition

<b>LANDSCAPE &amp; SOCIO-TECHNICAL REGIME FACTORS</b>	<b>PREVENTING A MANUFACTURING SUSTAINABLE TRANSITION</b>
Complex landscape forces	Domestic political and industry sustainability discourse causes confusion and minimal commitment/investment in sustainability
Sustainability seen as a cost	Absence of a business case for sustainability, 'have to' rather than 'want to' mindset
Incremental sustainability steps	Resource efficiency undertaken to save costs and increase market share
Technological focus	Production and output focus, sunk investments and seeking return on investment results in dependence on existing technology
Collaboration is internal	Limited ability, time and strategic intent for external collaborations. Minimal new collaboration models with customers
Limited emphasis on building internal capability	Traditional manufacturing style, family-owned businesses, 'too hard' basket, path dependence on production and output limiting exposure to new knowledge, skills and institutional reorientation
Compete on price	Employ processes that facilitate short-term solutions that improve profits and increase markets, rather than alternate thinking

The socio-technical regime factors illustrated in Table 7.2, slow down the attempts of 18 firms to generate different forms of path creation. Whilst eight firms rely on autocratic management styles, outdated workforce development strategies and internal collaboration, the process of adjustment is starting to build in ten firms. However, where these firms excel in demonstrating technological progress, they trail behind in embracing non-technological elements such as knowledge exchange, external collaboration and building transition capability.

A key contribution of the research findings within this thesis is the additional insight it provides for facilitating firm managerial decision making. Based on the results of a qualitative survey of 439 medium and large manufacturing firms in Australia, the Office of the Chief Economist (2016) found that there is a clear link between the quality of management for people, performance, operations and enterprise productivity. Chapter 4 similarly illustrates the significance of key non-technological management characteristics of 24 firms, and presents the organisational limitations of 18 firms that

inhibit transformational change. First, the level of education and skills held by both management and non-management employees is a determining indicator for firms embracing transition behaviours and exploring opportunities in sustainable markets. Second, family-owned businesses tend to exhibit inferior and autocratic management practices as a result of succession planning, based on appointing family members to key positions rather than recruiting externally or selecting individuals based on merit. Third, research findings suggest that eight manufacturing firms are process innovators. This is where firm innovative activity aims to reduce operational costs and improve resource efficiency, rather than designing and creating new product markets. Fourth, extra-regional networking and collaboration are essential features for establishing a high performing innovation system. The Office of the Chief Economist (2016) illustrates that Australia's innovation system is weakly networked internally, particularly in respect to the creation of intellectual property, joint research and development projects and trade in goods and services. The research findings similarly show that interfirm, extra-regional collaboration is a significant weakness across all 24 firms and is a major factor that inhibits change throughout Australian industry.

Nevertheless, the research in Chapter 4 clearly shows that six firms are reconfiguring towards a sustainable transition and developing niche-innovations. Table 7.3 illustrates the collective key emerging attributes across these firms and the subsequent contribution they make towards stimulating a manufacturing transition. Overall, the essential elements that steer organisational change include, creating a vision for sustainability, displaying leadership qualities and building future management capability, developing sustainable practices and behaviours, building workforce skills as well as embracing a culture of experimentation, innovation and collaboration. According to the Organisation for Economic Co-operation and Development (2016), as much as 50.0 per cent of member country long-term economic growth can be attributed to innovation, which subsequently stimulates new ways to envisage and implement change for the good of society. Thus, the findings from Chapter 4 indicate that the willingness and capacity of a firm to innovate depends on its stock of human capital and non-technological attributes, such as skills, knowledge and expertise embedded in its workforce and organisational culture. Furthermore, the transition behaviour and actions of the six firms show that increased levels of autonomy at the operational level, the introduction of flexible management styles to accommodate transition practices, a decentralisation of the decision-making process and fostering self-



managed work environments are all important; they enable niche-innovations to flourish and the creative potential of the workforce to be unlocked to generate a sustainable transition.

Table 7.3: Attributes of a sustainable transition across six firms

EMERGING ATTRIBUTES	CONTRIBUTION TO A MANUFACTURING SUSTAINABLE TRANSITION
Core vision of sustainability	Understanding drivers and barriers for change, sustainability principles embedded in organisation, new sustainable product, process and market development opportunities
Front runners & leaders of change	Building leadership capability in sustainable driven business
Invest in people	Building and facilitating future skills and knowledge in sustainability and innovation for manufacturing
Blended regional & extra-regional networks	Exploring alliances to value add: researchers, customers and other firms
Range of collaborations & partnerships	New non-traditional partnerships based on knowledge and innovation rather than raw materials and physical fabrication
Building capability for sustainable & innovative manufacturing	Exchange of knowledge & skills to access sustainable markets
Culture of experimentation	New ideas protected from day to day' business – materials, techniques, product, culture and people
Business model innovation	Driven by social, ecological and environmental goals
Technological innovation	Advanced use and development of sustainable materials and consumption practices, improved sustainable production processes and technological efficiencies
Design-based innovation	Sustainable behaviour change and influencing customer through experimentation

However, while each of the six reconfiguring firms embrace elements of transition dynamics and innovative management practices, they did not set out to design and implement a formal systematic transition strategy. Instead they assemble and adopt a range of change management strategies as incremental solutions. Chapter 4 further illustrates that engagement in continuous reflection and learning for monitoring firm sustainability performance was missing in all 24 firms. This key transition element is necessary for shaping a systematic framework for change.

By promoting a combined advanced manufacturing and sustainable transition lens, Chapter 4 makes three key contributions to current theory, technical application and professional practice. The first is how a more interdisciplinary and inclusive tool could contribute to influencing a manufacturing shift, if prospectively and purposefully applied as a systematic sustainable transition framework. As articulated by Geels (2010), Green and Roos (2012) and Loorbach and Wijsman (2013), such an assertion confirms the need to identify the components, functions and dynamics at play during system transitions

within the manufacturing sector. Second, the combined theoretical approach connects the more visionary and long-term aspects of transition research with the practical application and attainment of advanced manufacturing production techniques. Contemporary management practices, networks and organisational content, bring sustainability to the forefront of manufacturing. Third, for a sustainable transition, a business needs to adopt a holistic vision that incorporates social, cultural, institutional, technological, environmental and economic values; rather than an optimisation of existing mindsets, outdated management practices and systems. The 24 case studies illustrate that where the manufacturing regime is stabilised, firms struggle to reshape existing systems. But where destabilisation has begun to occur, a reconfiguration towards sustainability is taking place. Six firms demonstrate they have the management and people capabilities, resources, ingenuity and influence to achieve significant adjustment. Thus, a refined sustainable transition framework has the potential to encourage and enable traditional manufacturers to implement a more nuanced, practical and inclusive shift. Whilst Chapter 4 focused on the firm and sector system levels, Chapter 5 went on to discuss the limited application of transition theory in understanding the geography of manufacturing renewal in city regions of Australia.

### **Transitioning a manufacturing region - a spatial insight**

Chapter 5 empirically applies the second part of the Attributes of a Sustainable Transition theoretical framework illustrated in Figure 5.1 to analyse the important role city regions play in motivating a sustainable transition. More specifically, Chapter 5 answers the research question: what are the attributes of a sustainable transition for the traditional manufacturing region? Massey (1979); Peck (1996); Hudson (1999) and Cochrane (2012) all argue that a regional transition approach confirms the significance of the spatial lens for understanding regional transitions by analysing its path-dependent, related variety and proximity characteristics (Cooke 2009; Nelson and Winter 2009; Boschma et al. 2016). These features are essential ingredients for regenerating the traditional manufacturing sector. This analysis draws on Boschma et al.'s (2016) regional diversification typology to examine the relational, evolutionary and institutional features of three Australian manufacturing city regions: Newcastle, Geelong and Wollongong. This conceptual arrangement questions how and why transitions occur across the three geographies and more specifically, identifies the drivers and obstacles for renewal across three diversification trajectories including Replication, Transplantation and Exaptation.

A replication strategy is employed within each city region; it duplicates existing knowledge, experience and institutions currently embedded in the socio-technical regime (Table 7.4). Such a diversification logic sits comfortably with traditional manufacturing firms as limited pressure is applied on the existing regime, ultimately requiring it to make solitary incremental change. At the same time, this strategy locks the city region into a rational dependence on its existing path as a result of the political, cognitive and functional regime barriers associated with place. Table 7.4 illustrates that these barriers include: limited and centralised policy commitments for systematic change, which lack local nuance; maintain a culture of incremental process innovation; display a dominance for traditional industry structures and existing actors; specialise in mature clusters and technology; and limit engagement in research partnerships.

Table 7.4: Replication challenges for transition regions

CHALLENGES IMPACTING SOCIO-TECHNICAL REGIME	PREVENTING A MANUFACTURING SUSTAINABLE TRANSITION
<b>Replication Strategy – duplicating existing knowledge, experience and institutions embedded within the existing socio-technical regime</b>	
<i>Political Uncertainty</i>	<ul style="list-style-type: none"> <li>Lack of policy commitment for systematic change and innovation</li> <li>Global competition and trade policies create inequalities for exporting firms to compete</li> <li>Centralised policy decision rather than locally targeted ones</li> <li>Multiple agendas for change</li> </ul>
<i>Cognitive Lock-in</i>	<ul style="list-style-type: none"> <li>‘Group-think mind-set’ based on past experiences</li> <li>Culture of incremental technological innovation</li> <li>Dependence on history of place to provide jobs and growth</li> <li>Relational and socio-institutional fabric dominated by traditional industry and ‘usual’ suspects</li> <li>Existing knowledge infrastructure oriented towards traditional industries</li> <li>In-house learning strategies and learning by doing frameworks</li> </ul>
<i>Functional Impediments</i>	<ul style="list-style-type: none"> <li>Outdated infrastructure</li> <li>Sunk investments in technology and skills</li> <li>Transport assets geared towards ship, rail and road</li> <li>Specialisation in mature clusters</li> <li>Unskilled/semi-skilled labour pool</li> <li>Limited number of local research partnerships</li> </ul>

A replication strategy generates an advanced manufacturing agenda but positions sustainability as merely one component of reconfiguration, rather than visualising a systematic sustainable and innovative transition. Schot (2016) argues that such a perspective may lead to transformative change within a city region, but it only aims to optimise and not transition the system.

The empirical research findings from Chapter 5 have established that while pursuing a replication strategy, each city region also employs parallel diversification tactics. For example, in Geelong, supporting intermediary actors and firms are pursuing a transplantation strategy. A transplantation strategy (Table 7.5), involves developing an industry unrelated to its existing knowledge structures and institutions; in the process, this strategy directs the regional capability base towards a systematic transformation. To steer and prepare Geelong for change, the research findings show that a strategic city region agenda is guiding the development of clean technology manufacturing capability and research, facilitating central and state government funding programs as well as forming innovative collaborative alliances. As a result manufacturing firms are experimenting with: sustainable production techniques; material innovations for new product development; and novel alliances that provide further scope for developing or scaling up sustainable market-niches. Regional intermediary support is provided through financial assistance sources, professional development workshops and mentoring initiatives. Firms and city region actors are combining key attributes of learning and experimentation with new skills and capabilities, technological innovation and collaborative partnerships not observed before.

Table 7.5: Transplantation and exaptation attributes for transition regions

DIVERSIFICATION STRATEGIES	ATTRIBUTES CONTRIBUTING TO A MANUFACTURING SUSTAINABLE TRANSITION
Transplantation Strategy – developing an industry unrelated to its knowledge based and institutions. Adopting a regime technology from the global system	<ul style="list-style-type: none"> <li>Change in regional capability base – workshops, learning and investment</li> <li>Institutional support via change in norms, values, supporting intermediaries, actors and firms</li> <li>Integrated sustainability agenda</li> <li>Collaborative alliances</li> <li>Exploiting niche competitive-advantages of the city region</li> <li>Exchange of knowledge and skills to access sustainable markets</li> <li>Legislation in favour of sustainability</li> <li>Investment in new technology and capability building</li> <li>Leverage natural resources, connectivity and location for niche sustainable market development</li> </ul>
Exaptation Strategy – positioning manufacturing knowledge and technology to generate new sustainability niche innovations in related sectors	<ul style="list-style-type: none"> <li>Extra-regional partnerships</li> <li>Proximity to passenger infrastructure to access knowledge markets and partnerships</li> <li>Legacy of dominant industry mobilising the value chain and alliances</li> <li>Supported by intermediaries</li> <li>Group company leverage</li> <li>Social embeddedness of community</li> <li>Skilled labour pool</li> <li>Entrepreneurial partnerships</li> </ul>

At the same time, Chapter 5 demonstrates that where change is taking place, problems remain. Tensions exist between fragmented regional institutional agendas, which are slowing down efforts for systematic change. This situation is compounded by a deficiency in skills, gaps in education and learning networks and enabling infrastructure. As a result, while Geelong's strategic reorientation can be attributed to transplantation strategies, regional socio-technical limitations are inhibiting long-term sustainable change. In contrast, while Wollongong is locked-in to a replication strategy, transplantation is occurring at the firm level. Two firms bordering the city's geographical periphery demonstrate unrelated diversification is taking place. This finding disputes those of Todtling and Trippel (2005), who suggest that in outlying places with 'thin' institutional structures, transitions tend to struggle. Table 7.5 illustrates that change within these two firms involves building on internal capability, connectivity and proximity to mobilise relevant sources of knowledge and construct a competitive advantage for a sustainable transition; attributes found in Chapter 4 that stimulate innovation at the firm and regional level

An exaptation strategy, that positions manufacturing knowledge and technology to generate new sustainability niche initiatives in related sectors, is adopted in both Wollongong and Newcastle. Table 7.5 illustrates that this approach presents emerging attributes of knowledge and technology, but does not steer a systematic sustainable and innovative transition. Instead, this blended subsystem comprises internal and external knowledge partnerships driven by multi-national corporation global networks, a local skilled labour pool and collaboration with entrepreneurs and policy intermediary actors. Consequently, the strategy supports Newcastle's shift from its traditional industrial past to a globally connected, advanced manufacturing region. Such research findings correlate with studies conducted by the Department of Industry, Innovation, Science, Research and Tertiary Education (2008), which indicate international exposure is important for diversifying the company, internal knowledge and stimulating exports. The number of multi-national corporations that have a subsidiary presence in Newcastle indicates a greater level of commitment in building internationally oriented management and workforce capability, which subsequently stimulates innovation across the manufacturing sector and city region. These exaptation attributes are not as evident in Wollongong, and the city region has been less successful in promoting a strategic readjustment of its traditional manufacturing base. Instead, Wollongong remains internally dependent on the steelworks as a driver of economic growth and jobs.

However, both Newcastle and Wollongong, whilst presenting contradictory elements of change, display similar political and cognitive dependent challenges. Such blockages continue to preserve traditional industry structures and technological approaches to change, and deter a more strategic and systematic transition, which is evident in Geelong. Building upon Chapter 4, Chapter 5 demonstrates that where the city region regime is stabilised, a replication perspective is dominant, but where destabilisation is occurring, a combined exaptation and transplantation strategy is emerging.

Chapter 5 pays attention to the importance of analysing local spatial features for understanding transition dynamics, institutional change and governance challenges, particularly in city regions where intermediary support actors play such a large role in supporting and facilitating change. The transformational characteristics that appear similar, when viewed through an a-spatial lens, prove to be different when spatially analysed. These research findings substantiate the premise that regions differ with respect to their individual specialisation patterns, organisational routines, history, adaptation challenges and knowledge exchange (Trippel and Otto 2009). Hence, Chapter 5 demonstrates the significance for understanding the relational, evolutionary and institutional features of a city region to explain how and why transitions take place in different geographies.

Chapters 3 to 5 explored *supply* driven perspectives of a manufacturing transition, highlighting the prominence for considering supplier agency dynamics for successful change. Chapter 6 unites the elements of the Attributes of a Sustainable Transition theoretical framework, utilising key sustainable transition features from technological innovation systems theory together with elements from sustainable collaboration literature to explore the *demand* side of the transition inquiry. By exploring the role of the original equipment manufacturer ‘customer’, which is particularly unique to the manufacturer-supply chain relationship, and extra-regional collaboration for stimulating a supply-side transition, this completes a systematic analysis of the traditional manufacturing sustainable transition. Whilst previous work by Niesten et al. (2016) identifies limitations in understanding the emerging characteristics of sustainable supply chains, Chapter 6 goes some way to addressing this anomaly through the lens of the interfirm customer-supplier relationship.

## Interfirm customer-supplier collaboration for a sustainable transition

By employing the concepts of technological innovation systems and insights from the sustainable collaboration literature, Chapter 6 identifies the attributes of a sustainable transition across four separate customer (original equipment manufacturer) -supplier (manufacturer) case studies. This analysis utilises the key features that influence and determine how the supplier can innovate and adapt to meet the sustainability goals of the customer. In the process, the analysis highlights the challenges inhibiting change for the supplier as well as the attributes that stimulate a sustainable internal reconfiguration and shift beyond the manufacturer's traditional production ethos. This chapter introduces seven key emerging resource attributes that contribute to a manufacturing transition including, market-niche development, resource investment and mobilisation, creating legitimacy, directionality, demand articulation and policy coordination. Five key findings stand out from these results, illustrated in Table 7.6 which align with the outcomes of individual and collective firm transition activities in Chapter 4.

Table 7.6: Attributes of an interfirm customer-supplier collaborative transition

EMERGING ATTRIBUTES	CONTRIBUTION TO A MANUFACTURING SUSTAINABLE TRANSITION
Extra-regional collaboration with 'new' customers	Endogenous regional path-creation across supply chains Increase uptake of innovative opportunities, legitimacy, knowledge, market-niches, investment and direction
Customer embeds sustainability agenda	Enables selection of like-minded suppliers regardless of spatial proximity Encourages business model innovation in suppliers Enables supply chain reconfiguration
Imported knowledge from global groups	Exposes supplier to new learning environments Open innovation frameworks Learning by doing Generates collaboration with a higher degree of sustainable product innovation Selection of suppliers based on knowledge and capability rather than geographic location
Creation of market-niches	Technological development New business models for sustainability Products and services enable value add Sustainability experimentation in protected spaces
In-house sustainable policy coordination	Stimulates the market and fosters market-niche creation Creates legitimacy Builds business case for sustainability Investment in sustainability Key to driving a sustainable transition

The research findings show that in all four case studies, extra-regional collaboration with new customers outside the internal boundaries of the city region, introduced key resource formation attributes that enabled new path creation for both the customer and supplier. Suppliers who engaged in extra-regional, niche-customer collaboration tended to increase the uptake of innovative opportunities compared to firms that relied on internal resources or existing customers for innovation. These research findings align with those presented in the Australian Innovation Systems Report (Office of the Chief Economist 2016), which highlights that where firms collaborate, particularly with research institutions, the likelihood of businesses developing innovative capability triples. Such attributes are mobilised in a regional, yet internationally connected innovation system formed around a global technology and proximately positioned within the multi-national subsidiary group structure. While Crevoisier and Jeannerat (2009) argue that knowledge is the only stimulant resource for industry regeneration, in contrast, Chapter 6 reinforces the importance of multiple, in this case seven, key resource formation attributes for sustainable change. In addition, the findings substantiate Tether's (2002) analysis that group firms are able to draw on an array of other fundamental qualities to assist transition. These factors include legitimacy, directionality, demand articulation, policy coordination, market access and resource investment, as well as knowledge for developing an innovative and sustainable agenda. Multi-national corporations not only have the capacity for adopting a variety of management practices, but can also diffuse and transfer knowledge and practices in the local market. As a result, the customer is able to activate a strategic reorientation of the supplier's business model towards sustainability.

Table 7.6 illustrates that the strategic willingness of the customer to embrace a sustainability vision and agenda was critical for generating sustainable change throughout the components of the value chain.

Characteristics of strong sustainability principles, inserted within each case study customer, subsequently influenced a supplier reconfiguration. Kiron et al.'s (2015) assumption that when the combination of both sustainability-oriented collaboration and business model change occur, change is strongly correlated with sustainability-based profits, is confirmed by the findings of this chapter. It was shown that where all seven key resource formation processes were mobilised, a vision for sustainability was present.



Imported knowledge exchanged within an open innovation framework exposes the traditional manufacturer to new learning environments, transforming the incumbent firm in a localised learning by doing process. Such behaviours echo the 'Doing, Using and Interacting' contribution of Jensen et al. (2007), who promote the importance of tacit knowledge and practical know-how for successful collaborations. At the same time, the research findings contradict the perspective of such qualities being less transferable across geographical distance (Jensen et al. 2007). Instead, it is demonstrated that when mapping extra-regional supplier relationships, collaboration is associated with a high degree of innovation regardless of spatial proximity. Customers cite a preference to partner with a manufacturer which can meet specific technical needs, as opposed to selection based on whether they are locally proximate. Cognitive proximity, related variety and pre-existing competence are more important than physical location for a successful partnership.

Business management scholars such as Tether (2002), insist that few firms are able to work in isolation to generate a systematic transition. Thus, mobilising a range of stakeholders, imported knowledge and resources from other places enables new market-niches to form in each case study observed; subsequently encouraging technological development, business model innovation and associated change across the interfirm customer-supplier alliance. Chapter 6 illustrates the value of involving suppliers in new collaborative product development initiatives, as opposed to each firm working independently. These research findings also align with those presented of Loorbach (2010), who advocates that where creativity and entrepreneurial enterprise is limited in either the customer or supplier operations, collaborative efforts to establish an environment for experimentation opens up 'protected spaces' that stimulate innovative activity and provide a setting for niche alternatives.

Finally, drawing on the contributions of Weber and Rohrer (2012), who identified failures of transformative change, internal and external policy coordination initiatives can both incentivise and disincentivise firm efforts to transition. On one hand, internal policy measures identified in Table 7.6 such as strategic plans, contracts and standards in favour of sustainability projects foster market-niches and innovative activity. On the other hand, Table 7.7 illustrates that ongoing debates involving external government policy deliberations on climate change and sustainability cause confusion, limit scale-up,

investment and renewed capability for building legitimate clean technology markets and product innovation, which could otherwise speed up transformative change across the supply-chain.

Table 7.7: Policy coordination challenges preventing a collaborative transition

CHALLENGES IMPACTING SOCIO- TECHNICAL REGIME	PREVENTING A MANUFACTURING SUSTAINABLE TRANSITION
External policy coordination – increased and confusing discourse and action	Inhibiting transformative change for customer and supplier
	Limited scale-up
	Limited investment in sustainability
	Limited sustainability capability building opportunities

More generally, Chapter 6 establishes that the formation of extra-regional partnerships are critical for steering manufacturing supply-chain transitions; it is also clear that greater emphasis needs to be placed on building the cognitive relatedness attributes within an interfirm customer-supplier relationship rather than seeking a purely locally driven partnership. The findings indicate that customers consider supplier selection is a critical step in successfully achieving their overall business strategy. So, suppliers need to work on inserting themselves securely into such collaborative arrangements.

By combining the concepts of technological innovation system and sustainable collaborations literature, the chapter provides a holistic overview of systematic innovation for generating a sustainable transition, through the blended nature of technology focused approaches and socio-technical environment features. Whilst the transition literature emphasises the role of path-dependency in inhibiting systematic change in incumbent firms, Chapter 6 illustrates that the interfirm customer-supplier alliances can be a significant force in overturning such a reliance mind-set. Instead, the partnership triggers innovative thinking and agile, collaborative behaviour that benefits both actors. It is important to emphasise the value of paying attention to the role of interfirm collaboration in order to understand the development of a future manufacturing sector transition in a rapidly changing, globalised society.

Chapter 3 developed and exhibited a new integrated interdisciplinary framework to identify the attributes of a sustainable transition in the traditional manufacturing sector. The subsequent chapters have empirically tested this hypothesis at firm, sector, city region and interfirm customer-supplier levels of analysis. Table 7.8 condenses and represents the attribute findings of each chapter.

Table 7.8: Emerging attributes and challenges of a sustainable transition for the traditional manufacturing sector

	<b>Attributes</b>	<b>Challenges</b>
<b>Firm/Sector Level (Chapter 4)</b>	<ul style="list-style-type: none"> <li>▪ Core vision for sustainability</li> <li>▪ Front runners and leaders of change</li> <li>▪ Investments in people</li> <li>▪ Blended regional and extra-regional networks</li> <li>▪ Diverse collaborations and partnerships</li> <li>▪ Capability building for sustainable and innovative manufacturing</li> <li>▪ Culture of experimentation</li> <li>▪ Business model, technological and design-based innovation</li> </ul>	<ul style="list-style-type: none"> <li>▪ Complex landscape socio-technical pressures</li> <li>▪ Sustainability seen as a cost</li> <li>▪ Incremental sustainability steps</li> <li>▪ Technological focus</li> <li>▪ Collaboration is internal</li> <li>▪ Limited emphasis on building internal capability</li> <li>▪ Compete on price</li> </ul>
<b>City Region (Chapter 5)</b>	<ul style="list-style-type: none"> <li>▪ Development of industry unrelated/related to knowledge base and institutions</li> <li>▪ Change in regional capability and institutional base</li> <li>▪ Integrated sustainability agenda</li> <li>▪ Collaborative regional and extra-regional alliances</li> <li>▪ Niche competitive advantage</li> <li>▪ Knowledge and skill spillover and exchange</li> <li>▪ Investment in new technology and capability building to support sustainable and innovative transition</li> <li>▪ Leverage natural resources, connectivity and location, MNC and entrepreneurial networks</li> <li>▪ Improve capacity of existing learning providers to deliver new and relevant skills/knowledge</li> <li>▪ Tackle bottlenecks and develop tailored policy</li> </ul>	<ul style="list-style-type: none"> <li>▪ Political uncertainty (policy commitment, globalisation, centralised/fragmented agendas)</li> <li>▪ Cognitive lock-in (mind-set based on past, incremental innovation, institutions dominated by traditional structures)</li> <li>▪ Functional impediments (outdated infrastructure, sunk investments, specialisation)</li> </ul>
<b>Interfirm Customer-Supplier (Chapter 6)</b>	<ul style="list-style-type: none"> <li>▪ Extra regional collaboration with new customers</li> <li>▪ Embedded sustainability agenda</li> <li>▪ Imported knowledge absorption</li> <li>▪ Creation of market-niches</li> <li>▪ In-house policy coordination</li> <li>▪ Legitimacy</li> <li>▪ Demand articulation</li> </ul>	<ul style="list-style-type: none"> <li>▪ External unsupportive policy coordination (inhibits transformative change, limits scale up, investment and capability building)</li> </ul>

## **Implications of findings for scholars, policy makers and practitioners**

This section discusses the theoretical and practical implications of the research findings for transition scholars, policy makers, practitioners and Australian manufacturing firms.

### ***Where to for transition scholarly research***

A significant strength of the transition perspective is its ability to examine and address change at the system level which is crucial for progressing transition research. This outlook enables scholars to tackle multiple themes in the context of empirical case study analysis. To this end, this thesis contributes to the transition studies discipline by extending existing conceptual approaches in terms of where and how they can be applied, while also exploring complementary ideas among the four integrated concepts. By positioning the scope of the study within the manufacturing arena, this thesis addresses calls from Markard, Geels and Loorbach (2010) and Markard, Raven and Truffer (2012) to widen transition inquiry to include new empirical domains and move beyond its current focus on urban, energy and mobility transition studies. Specifically, the current thesis considers how new sustainable innovations and practices struggle to take shape within incumbent manufacturing systems, where transition behaviours can exert greater influence. The significance of this research for sustainable transition theory is that when an Attributes of a Sustainable Transition theoretical lens is applied to the traditional manufacturing domain, it provides a systematic analysis; then subsequent mechanisms are required to strategically shift a complex and conventional regime towards a new sustainable trajectory. The thesis operationalises three core typologies of transition inquiry including, the multi-level perspective, transition management and technological innovation systems and aligns these with interdisciplinary concepts within geography and collaboration studies. Manufacturing firms are critical actors in influencing a transition of the global production process, and possess fundamental assets and resources for stimulating change. So, understanding the role of the firm and broader industry stakeholders in the transition process can assist in developing new opportunities, which initiate and enable long-term sustainable change.

This thesis has particularly contributed to two specific gaps in the transition literature. These are: a) addressing how and why incumbent manufacturing firms reorient current business strategies, that generate sustainable niche-innovations; and b) understanding how firms and other actors more

generally shape their institutional environment, through analysing the different roles of agency and strategic alliances. In response to Coenen and Truffer (2012), Cooke (2010) and, Hansen and Coenen (2015) who call for transition studies to explore new geographies and spatial scales of transitions outside Europe, this thesis makes further contributions in examining why transitions occur in one place and not another, as well as the role of cities and regions in the transition process. Markard, Geels and Loorbach (2010) argue that existing analyses draw predominantly on single comparative case studies and fail to explain how and if the spatial context matters at all. The current study addresses these deficiencies through analysing transitions in Australia, where the political, institutional, geographical, social and economic context differs from elsewhere. It applies a cross-comparative case study analysis of 24 firms and three city regions to reinforce the need to understand transition behaviours and practices at the national, regional and firm spatial scales.

The Attributes of a Sustainable Transition theoretical framework has combined four conceptual perspectives to address gaps in the literature. An interdisciplinary approach broadens the discussion beyond a focus on innovation policy journals to also influence thinking within the fields of management, production and operations, regional studies, geography, business strategy and industrial economics. A mixed method and ‘transitions in practice’ research approach engages essential actors and institutions missing from the current sustainable transition conversation, particularly in regional areas. While it also deepens the empirical analysis using tangible case studies to reveal transition attributes, elements and challenges. As Lachman (2013) implies, the possibilities for future interdisciplinary research are endless, and the very fact that transition scholars attempt to synergise with other specialities is a definite advantage of transition research, displaying its open and dynamic nature.

### ***Where to for government policy makers and practitioners***

As research institutions face growing pressure to produce meaningful industry engagement and applied research outcomes, the current thesis addresses a science-practice gap. As Loorbach (2010) points out, policy and practice recommendations have been missing from the transition debate. The Attributes of a Sustainable Transition theoretical framework and empirical research findings contribute to the development of an interdisciplinary model to guide policy makers and relevant practitioners to activate sustainable transitions in a manufacturing industry context. The findings also go some way to

promoting three of the 17 key UN Sustainable Development Goals (United Nations General Assembly 2015) ‘for transforming our world’, and listed in the introductory chapter. In the last decade, Australian and state governments have significantly invested in sustainability program initiatives, subsequently motivating and galvanising confidence within sustainable oriented communities. However, numerous changes in government policy agendas, including a repeal of the Clean Energy legislation in 2014, have created ongoing debate around the politics of developing future ‘sustainable’, ‘green’ and ‘low carbon’ economies. Despite these disruptions, Australian communities, towns and regions continue to attract corporate support to pursue sustainable development goals. Small and large industry firms maintain their investments in cleaner, efficient production methods, developing sustainable product alternatives and recycling activities; and academia and research institutes continue to work in partnership with private enterprise to commercialise sustainable innovative projects.

This thesis offers policy makers, government and non-government practitioners, new knowledge about the challenges and attributes for achieving successful sustainable evolution as well as an opportunity to enter the transition discourse. If facilitated and adopted more generally, the outcomes of this research could contribute towards a comprehensive policy response across a range of government levels, to guide the manufacturing transition in regions of Australia. Such an instrument incorporating a ‘tool-box of strategies’ to be implemented at local, regional and national levels will contribute to building new capabilities and resources for the manufacturing sector. The key findings contribute to enabling green economic development and a transition towards a lower carbon economy, and an opportunity to make a significant global contribution to the survival of the planet. At the same time, the study generates a broader understanding of how the social, political and institutional differences contained within a place influence transitions on the ground. Four policy themes in particular, are proposed for steering government action towards a sustainable transition. These include a focus on management, stimulating innovation and sustainability action, promoting diversity and establishing programs for success.

## **A focus on management**

***Effective leadership and management driving innovation and sustainability.*** State and Australian government programs should target management and leadership development across the manufacturing sector. Such an agenda needs to be communicated, coordinated and steered at the local, regional and national level, with oversight by the Advanced Manufacturing Growth Centre, and implementation by key intermediaries appropriately positioned in each city region. Examples of facilitating actors include, regional state departments of trade and investment, regional development agencies, local council economic and sustainable development units, business chambers or offices within the Australian industry Group, to name a few. Such a policy objective would build upon the vision and competitiveness agenda set by the Australian government's growth centre initiative and Australia's Innovation System Report (Table 1.1), and be positioned within a local context.

## **Stimulating innovation and sustainability action**

***Diverse sustainable and innovation discourse facilitating system transition.*** The innovation and sustainability conversation needs to be extended beyond technological investment and product development. Instead, a diverse dialogue, as part of a government and non-government interdisciplinary taskforce, is required that concentrates on the social, political, institutional and environmental characteristics of manufacturing transitions in places, complemented by renewed management practices and methods of operating rather than implementing singular and disconnected business sustainability strategies from other parts of the firm.

***Invest in a 'seventh' industry growth centre.*** Facilitated by the Australian government, a seventh industry growth centre focused on sustainable development would convey a clear political message regarding its commitment to creating a lower carbon future and addressing the environmental and industry policy challenges (Table 1.1). Investment in science and technology research could boost green economic growth with a particular focus on employing bespoke strategies in key regional areas where strengths in sustainable and clean technology capacity have been recognised. In collaboration with relevant city regions, the centre would advance education infrastructure resources, skill development across the managerial domain, workplaces and schools and build collaborative networks with other firms or research organisations to cultivate a sustainable future.

## **Promoting diversity**

***Diversity of Australian manufacturing sector should be championed.*** The research findings within this thesis illustrate that although there are a range of existing transition challenges impacting the manufacturing firm, there are also a significant number of small, medium and large firms showcasing transition success stories, demonstrating the diversity of the sector. Such evidence, which comprises a range of global trading initiatives, niche-innovations, partnerships and alliances, enables diversification and growth within the domestic and international marketplace. These achievements should be celebrated and promoted to recognise the individual firm and the Australian manufacturing sector as a whole. Case studies could be developed by the Department of Innovation, Industry and Science to stimulate the flow of communication between different actors and future collaborative idea generation and knowledge exchange across the sector.

***Cross-sector collaboration needs to be facilitated.*** The Australian industry Group, Department of Trade and Investment and regional development agencies are well placed to facilitate cross-regional and cross-sector related and un-related collaboration. Promotional mediums such as newsletters, social media, industry workshops and face-to-face connections could be organised to encourage related and unrelated sectors to collaborate. Such tactics would assist individual businesses access new markets and build capacity for operating within a global value chain.

## **Establishing programs for success**

***Encouragement of multi-national and entrepreneurial collaboration.*** The research findings have illustrated the value of multi-national corporation and entrepreneurial alliance building. Such partnerships improve the productivity performance of manufacturing firms through foreign investment in key sustainable industries, generate knowledge exchange and future long-term connections. Firms often experience difficulty in scaling-up niche-innovations to reach full capacity, and such collaborations would alleviate these issues by opening global export channels for domestic firms and introducing new market opportunities. In particular, entrepreneurial alliances with start-up firms should be encouraged to establish new capabilities where a shortfall in current skills may exist within larger traditional regime establishments.



***Manufacturers as service-producing sectors.*** Research findings within this thesis demonstrate that the manufacturing sector is also a sizeable contributor to the service industry in the form of maintenance and consulting contracts. Such service sector qualities are often not recognised or understood.

Acknowledging this important role of manufacturing firms will assist in shifting Australia's perception of traditional industries as large physical factories to a sector that is diversified and rich in expertise; contributing to the growing domestic service and innovation economy.

***Manufacturing Taskforce revival.*** The Prime Minister's Manufacturing Taskforce, established in 2012 by the Gillard Labor government, could be revitalised with a renewed agenda that guides policy recommendations and encourages place-specific sustainability strategies. The Taskforce launched the *Smarter Manufacturing for a Smarter Australia* initiative in 2012 to guide future manufacturing direction, but was later disbanded upon a change of government. In April 2017, under the guise of the Turnbull Coalition-Government, the Prime Minister's Industry 4.0 Taskforce was announced; and collaborations were forged with Germany, aimed at improving Australia's transformation capability. A renewed Manufacturing Taskforce built upon a science and technology and socio-technical transition agenda, could facilitate a more systematic shift of the traditional manufacturing sector. More specifically, by incorporating a spatial lens, engaged city region actors could contribute program ideas that focus on understanding the specific socio-technical cognitive, functional and political regime drivers and barriers for change across industry.

Policy makers would do well to acknowledge the attributes for change and associated challenges that enable and at the same time, work against steering a sustainable transition of the traditional manufacturing sector. This enabling environment could stimulate wider transition activity at varying spatial scales and contribute to stimulating profitability, growth and green economic development. The narratives presented within this thesis provide a detailed perspective into how policy makers and firms can collaboratively consider, and operationalise, such a fundamental transformation, rather than optimising the status quo.

### **Where to for Australian manufacturing firms**

The key emerging attributes presented in this thesis could be strategically considered by manufacturing firms and the wider industry sector to influence the change process, address challenges of optimisation

and support enabling mechanisms for sustainability. Understanding the socio-technical regime dynamics, regional path and place-dependent characteristics and organisational routines that inhibit change, whether at the firm or sector or city region level is crucial to activating a sustainable transition of the manufacturing system. The thesis findings particularly illustrate the significance of three key attributes for stimulating a sustainable transition; these include developing a core vision for sustainability, building the transition capability of managers and workforce as well as improving interfirm and external collaboration:

***Developing a core vision.*** By investing in transition management techniques, the strategic vision of the traditional manufacturing firm can be reimaged. A sustainable transition vision embraced ‘at the top’ and throughout the organisation provides the enabling conditions to deliver internal policies for change. Such leadership motivates product and process innovation, based not only on efficiencies and cost but also productivity gains, when entering new niche markets.

***Building transition capability.*** The research findings suggest that over three-quarters of respondent firms are either optimising operational status-quo or managing resources to increase efficiency and cut costs. In order to trigger a future sustainable and innovative transition of the manufacturing sector and meet the shifting needs of its future end-user, higher level skillsets, capability and education across firm management and workforce levels need to be improved.

***Improving interfirm and external collaboration.*** This research illustrates the range of opportunities manufacturing firms have to collaborate with a mixture of businesses, research organisations, competitors and customers. However, limited time, resources, expertise, know-how and capacity restrict many small to medium firms from taking opportunities to build new alliances. Empirical findings from case studies show the advantages of instigating diverse and multiple collaborations. But a collaborative mindset and subsequent internal behaviour needs to be encouraged to activate such external connections beyond the boundaries of the city region and internal firm resources.

### **Limitations of this research and future directions**

Overall, the research demonstrates that the Attributes of a Sustainable Transition theoretical framework has made a significant contribution to identifying the attributes of a sustainable transition in traditional

manufacturing industry sectors in regions of Australia. As one of the recognised gaps in transition research is the level of inquiry into new empirical domains, an investigation into the traditional manufacturing sector signifies a step towards closing this gap. Future research is needed to replicate the current findings in other manufacturing and industry settings.

As these studies focused on identifying the attributes of a sustainable transition for the traditional manufacturing sector, it did not hypothesise the causation effects of intersecting sustainable transition perspectives that shift the firm from one transition phase to the next. Further investigation is warranted that analyses the correlation between the transition phases for case study firms in Chapter 4, extending discussion on the causality for transition from one context to another. Such analysis could further explain the complexities of regime destabilisation through the introduction of experiments and niche-innovations. This would be important in the reconfiguring stages of transition activity. Further investigation leading on from Chapter 4 would emphasise the implication that sustainable transition research has for general managerial decision making in progressing sustainable economic development initiatives.

Chapter 5 responded to the need to clarify the extent to which regions specialise in one diversification trajectory over another (Boschma et al. 2016). The roles of various actors in the process and the types of conflicts that emerge also require investigation. Future research is necessary to analyse such transition features and system diversification attributes in more detail, particularly in terms of how influencing relationships and power struggles contribute to spatial evolution and how constraints may be overcome. Such an analysis would address Cooke's (2009) inquiry for an exploration of the conditions under which findings from one spatial context may or may not be transferred to another. The research findings also point to the need for further examination of the role and influence of entrepreneurial, multi-national enterprise and cross-regional collaborations for steering sustainable transitions.

Whilst Chapter 6 concentrated on understanding the role of the interfirm customer-supplier relationship in a sustainable transition, it did not explore the confounding cases studies that displayed less collaborative environments for stimulating change, or the ability to consider the alternatives pursued that may have opened up lines of enquiry for future research. It would be useful to further examine

competitor alliances outside existing supply chain channels, if only to understand the impact of unintended consequences of such relationships for transition outcomes, as firms try to avoid direct knowledge transfer to rivals.

A final limitation of the thesis is that its main focus has been on the traditional manufacturing sector located in regions of Australia. While the thesis contributes to the breadth of knowledge involved in understanding processes for a transition, comparisons with similar industry sectors in other national and global contexts could inform a wider set of policy instruments and interactions, with alternative theoretical frameworks at the national, regional and local level.

Taken together, the research findings from this thesis, support the hypothesis that the Attributes of a Sustainable Transition theoretical framework can successfully identify existing and emerging features of a transition within the cases studied. Furthermore, an overall observation of the current thesis is that while each chapter contributes to the identification of emerging attributes for a sustainable transition in the traditional manufacturing sector, they also highlight the complexities associated with such change for an incumbent regime. The evidence presented goes some way to demonstrating a shift of the 'old' conventional manufacturing firm towards one that is pursuing a 'new' advanced, sustainable economy; in the process, generating practical and alternative pathways for regional renewal. As the world moves rapidly towards significant economic, social and environmental change, it is hoped that the findings presented here can contribute to much needed transformation within the manufacturing sector, and stimulate greener and more sustainable production and consumption patterns.

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# Appendices

- Appendix A:** Participant Information Sheet and Consent Form (PISCF)
- Appendix B:** Ethics approval letter
- Appendix C:** Copy of Manufacturing research questions and themes
- Appendix D:** Example of City-Region Newcastle presentation
- Appendix E:** Focus Group questions addressing aim and research themes
- Appendix F:** Research questions for customers
- Appendix G:** Chapter 3 – Article abstract
- Appendix H:** Chapter 4 – Article abstract
- Appendix I:** Chapter 5 – Article abstract
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- Appendix K:** AIRRANZ 2015 Conference abstract
- Appendix L:** International Sustainable Transitions Conference abstract 2016

## **Appendix A: Participant Information Sheet and Consent Form (PISCF)**



Department of Marketing and Management  
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**Phone: +61 (0)438 459540**

Email: [katrina.skellern@students.mq.edu.au](mailto:katrina.skellern@students.mq.edu.au)

Chief Investigator's Name: Raymond Markey

Chief Investigator's Title: Professor Employment Relations/Director, Centre for Workforce Futures

### **Participant Information and Consent Form**

Name of Project: *'Attributes of a Sustainable Transition'*

You are invited to participate in a study to identify attributes of successful sustainable transitions for traditional manufacturing industry across regions in Australia. The purpose of the study is to engage 'customers' (demand) and 'manufacturers' (supply) to ascertain the key elements and attributes of a transition towards a sustainable trajectory within the manufacturing industry sector. For the manufacturer, the study will explore current sustainable transition strategies, capabilities, business development strategies, existing supply and demand channels, skills and development, barriers to change, existing and potential collaborations and other key attributes.

Manufacturers in Geelong, Newcastle and Wollongong will be engaged in the research project and with the permission of the organisation, it is hoped that regional connections and collaborations can be made that open up further sustainable business opportunities.

The study is being conducted by Katrina Skellern, Centre for Workforce Futures, Business & Economics Faculty, Department of Marketing & Management, contact details: mobile 0438 459540, [katrina.skellern@students.mq.edu.au](mailto:katrina.skellern@students.mq.edu.au) to meet the requirements of Doctor of Philosophy (PhD) under the supervision of Professor Raymond Markey, 02 98507444, [ray.markey@mq.edu.au](mailto:ray.markey@mq.edu.au) and A/Professor Louise Thornthwaite, 02 98508489, [louise.thornthwaite@mq.edu.au](mailto:louise.thornthwaite@mq.edu.au), Centre for Workforce Futures.

If you decide to participate, you will be asked to take part in a one and half hour interview to discuss the information outlined above. The interview will be recorded on an audio recorder to support the researcher's note taking and to ensure an accurate account of the discussion is captured.

Any information or personal details gathered in the course of the study are confidential, except as required by law. No individual will be identified in any publication of the results. The researcher and supervisor will be the only individuals who have access to the data. A summary of the results of the data can be made available to you on request to the researcher.

Participation in this study is entirely voluntary: you are not obliged to participate and if you decide to participate, you are free to withdraw at any time without having to give a reason and without consequence.

I, *(participant's name)* have read *(or, where appropriate, have had read to me)* and understand the information above and any questions I have asked have been answered to my satisfaction. I agree to participate in this research, knowing that I can withdraw from further participation in the research at any time without consequence. I have been given a copy of this form to keep.

Participant's Name: \_\_\_\_\_  
(Block letters)

Participant's Signature: \_\_\_\_\_ Date: \_\_\_\_\_

Investigator's Name: \_\_\_\_\_  
(Block letters)

Investigator's Signature: \_\_\_\_\_ Date: \_\_\_\_\_

The ethical aspects of this study have been approved by the Macquarie University Human Research Ethics Committee. If you have any complaints or reservations about any ethical aspect of your participation in this research, you may contact the Committee through the Director, Research Ethics (telephone (02) 9850 7854; email [ethics@mq.edu.au](mailto:ethics@mq.edu.au)). Any complaint you make will be treated in confidence and investigated, and you will be informed of the outcome.

**(INVESTIGATOR'S [OR PARTICIPANT'S] COPY)**



## **Appendix B: Ethics Approval Letter**

Dear Prof Markey,

Re: 'Identifying attributes of successful sustainable transitions for traditional manufacturing industry regions in Australia.'

Reference No.: 5201500130

Thank you for your recent correspondence. Your response has addressed the issues raised by the Faculty of Business & Economics Human Research Ethics Sub Committee. Approval of the above application is granted, effective '30/03/2015'. This email constitutes ethical approval only.

This research meets the requirements of the National Statement on Ethical Conduct in Human Research (2007). The National Statement is available at the following web site:

<http://www.nhmrc.gov.au/files/nhmrc/publications/attachments/e72.pdf>.

The following personnel are authorised to conduct this research:

Dr Louise Thornthwaite

Ms Katrina Jayne Skellern

Prof Ray Markey

NB. STUDENTS: IT IS YOUR RESPONSIBILITY TO KEEP A COPY OF THIS APPROVAL EMAIL TO SUBMIT WITH YOUR THESIS.

Please note the following standard requirements of approval:

1. The approval of this project is conditional upon your continuing compliance with the National Statement on Ethical Conduct in Human Research (2007).
2. Approval will be for a period of five (5) years subject to the provision of annual reports.

Progress Report 1 Due: 30th Mar. 2016

Progress Report 2 Due: 30th Mar. 2017

Progress Report 3 Due: 30th Mar. 2018

Progress Report 4 Due: 30th Mar. 2019

Final Report Due: 30th Mar. 2020

NB. If you complete the work earlier than you had planned you must submit a Final Report as soon as the work is completed. If the project has been discontinued or not commenced for any reason, you are also required to submit a Final Report for the project.

Progress reports and Final Reports are available at the following website:

[http://www.research.mq.edu.au/for/researchers/how\\_to\\_obtain\\_ethics\\_approval/human\\_research\\_ethics/forms](http://www.research.mq.edu.au/for/researchers/how_to_obtain_ethics_approval/human_research_ethics/forms)

3. If the project has run for more than five (5) years you cannot renew approval for the project. You will need to complete and submit a Final Report and submit a new application for the project. (The five year limit on renewal of approvals allows the Committee to fully re-review research in an environment where legislation, guidelines and requirements are continually changing, for example, new child protection and privacy laws).

4. All amendments to the project must be reviewed and approved by the Committee before implementation. Please complete and submit a Request for Amendment Form available at the following website:

[http://www.research.mq.edu.au/for/researchers/how\\_to\\_obtain\\_ethics\\_approval/human\\_research\\_ethics/forms](http://www.research.mq.edu.au/for/researchers/how_to_obtain_ethics_approval/human_research_ethics/forms)

5. Please notify the Committee immediately in the event of any adverse effects on participants or of any unforeseen events that affect the continued ethical acceptability of the project.

6. At all times you are responsible for the ethical conduct of your research in accordance with the guidelines established by the University. This information is available at the following websites:

<http://www.mq.edu.au/policy/>

[http://www.research.mq.edu.au/for/researchers/how\\_to\\_obtain\\_ethics\\_approval/human\\_research\\_ethics/policy](http://www.research.mq.edu.au/for/researchers/how_to_obtain_ethics_approval/human_research_ethics/policy)

If you will be applying for or have applied for internal or external funding for the above project it is your responsibility to provide the Macquarie University's Research Grants Management Assistant with a copy of this email as soon as possible. Internal and External funding agencies will not be informed that you have approval for your project and funds will not be released until the Research Grants Management Assistant has received a copy of this email.

If you need to provide a hard copy letter of approval to an external organisation as evidence that you have approval, please do not hesitate to contact the FBE Ethics Committee Secretariat, via fbe-ethics@mq.edu.au or 9850 4826.

Please retain a copy of this email as this is your official notification of ethics approval.

Yours sincerely,

Dr. Nikola Balnave

Chair, Faculty of Business and Economics Ethics Sub-Committee

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## **Appendix C: Copy of Manufacturing research questions and themes**

### **Semi-Structured Interview Questions – Manufacturer**

**Aim (for researcher purposes only):** Explore current sustainable transition strategies, capabilities, business development strategies, existing supply and demand channels, skills and development, barriers to change, existing and potential collaborations and other key attributes.

#### **Manufacturer Details (to be included for each organisation)**

- Manufacturer/Organisation name:
- Contact details; address, email, phone, website:
- Interviewee name & position:
- Gender M/F:
- Age: 18-24, 25 – 30, 31-35, 36-40, 41-45, 46-50, 51-55, Above 55
- Qualification level:
- Length of employment in organisation:
- Date of Interview:

#### **Section A: Business Insight**

1. In what year was your organisation established?
2. Please describe the core business of your organisation? i.e. energy, waste, construction, etc.
3. What are your primary products/outputs/services?
4. How many people does your organisation employ?
5. What % (estimate) of employees have qualifications? HSC, degree, etc.
6. What is your average annual gross turnover? (Complete category from list) - under \$1 million, between \$1 million and \$5 million, \$5 million to \$10 million, \$10 million to \$100 million, \$100 million and above
7. Can you provide a sales revenue % of main markets i.e. NSW, Australia, International?

#### **Section B – Value/Supply Chain Linkages**

8. What are the industry sector(s) where your services/outputs/products are distributed?
9. Where is your total geographic output distributed? i.e. within your region, Greater regional area, capital city, NSW, other Australian location, International
10. Please name the top 2-3 customers for your organisation's output and the product or service they consume, their location and the length of relationship with them?
11. Do these customers seek sustainable credentials? Please provide details
12. Are there challenges with meeting the sustainability requirements of these customers? How are these challenges overcome?
13. Do you see opportunities to work better with your current or future customers? Provide detail

#### **Section C – Sustainable Transition (apply these questions to trigger narrative and response where appropriate)**

14. How has your core business transitioned/changed from when it was first established?
15. What is driving the need for your change/transition? i.e. structure (how things are organised), culture (shifts in thinking), practice (what and how do it)
16. How have you purposefully positioned 'sustainability' within your business and has pursuing a sustainable pathway assisted in the transition of the business?

17. What are the elements/attributes that have contributed to your business transition? What have hindered/blocked or challenged? Allow the interviewee to provide their own response then provide a list of my requests and ask them to see which of these contributed. (List will explore technological, social and governance, niche, landscape, regime, system, trends)
18. Are there particular systems/regimes in your organisation which are difficult to 'unlock' to be able to change course? Will a sustainable pathway unlock these processes?
19. What processes/support did you have in place to coordinate your transition?
20. What firm or personnel capabilities do you have or would like to build upon to improve this transition?
21. Are there elements/activity that you would have done differently?
22. What policy/government support have you received to enable your transition?
23. Has the current political climate had an impact on your sustainable transition – negative/positive/no affect?

## **Section D - Business Development**

24. Has your transition opened new market opportunities for you? Provide detail
25. What growth opportunities do you see for your business as a part of this transition?
26. Are there any sustainable business development/growth opportunities which you cannot meet due to supply chain issues, capacity, capability or skills constraints, regulatory or other impediments or barriers to entry? Provide detail
27. What processes and systems changes have you made to pursue new product/service opportunities? i.e. business model, niche activity
28. What advice and support have you received to enable these changes?

## **Section E - Regional links**

29. Would you be willing to collaborate to seek new opportunities across your organisation? If yes, how?
30. Is your organisation currently undertaking any activities that involve collaborating with other organisations to achieve its sustainable business functions? If yes, provide detail, i.e. joint ventures, research and development, innovation, funding, networking, training etc.
31. On a scale of 1 – 10, how important do you perceive the following factors to your organisation's core day-to-day activities? (Complete category from list)
32. On a scale of 1 – 10, how do you rate your regional location with respect to fulfilling your organisation's needs in terms of the above factors?
33. What challenges does your organisation face in its sustainable transition as a result of being based in your regional location?

## **Section F - The future**

34. Where do you see the future for your organisation?
35. What do you think can help you get there?
36. Who do you think can help with or provide the solutions?

## Appendix D: Example of City-Region Newcastle presentation (adapted and presented for each city region)



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WORKFORCE FUTURES

*Identifying attributes of sustainable transitions for traditional manufacturing industry across regions in Australia*



Source: Illawarra Mercury (2013)

### Background – why this research project?

- ▶ Green Jobs Illawarra Project Manager, RDAI, NSW
  - ▶ Networks and case study access
- ▶ Heavy industry dominant region(s)
- ▶ Struggle to 'shake-off' stereo-type and see new opportunities
- ▶ Limited government and industry direction and support
- ▶ Too many tested and 'tried' projects – inter-regional collaboration
- ▶ Potential, potential, manufacturing has a future in Australia!



### Impact of Research

1. Present business development opportunities
2. Inter-regional collaborations
3. Build on community/industry momentum & investment
4. Understand elements of sustainable transitions
5. Development of new practical framework/knowledge
6. Contribution to a future manufacturing sector
7. Coupling environment and economy for sustainable alternative



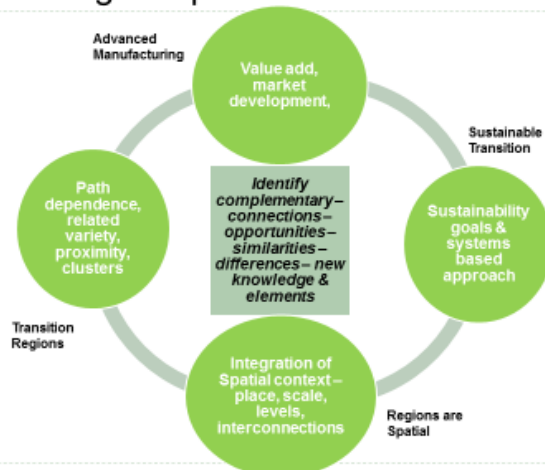
## Research Problem

- ▶ Changes in social, economic & environmental future:
  1. Climate change
  2. Economic shift to innovative/high-value manufacturing
  3. Impact on local and regional communities
- ▶ A 'transition' is needed to address challenges:
  - ▶ 'Sustainability' v 'business as usual'
  - ▶ Different sustainable approaches
    - ▶ Explored in singular studies = gaps
    - ▶ Limited evidence drawing approaches together
  - ▶ What does a transition look like?

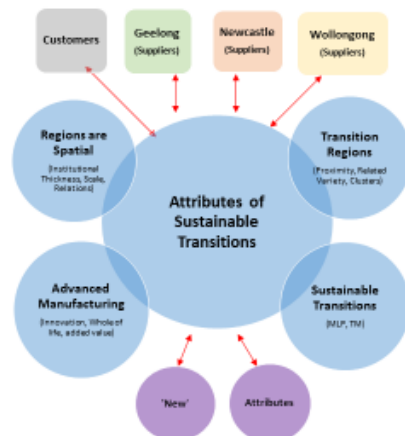
## Four concepts that consider elements of relevant transitions:

- ▶ Advanced Manufacturing
- ▶ Sustainable Transitions
- ▶ Regions within spatial context
- ▶ Transition Regions

## Addressing the problem.....



## What does the 'Attributes of Sustainable Transitions' Framework look like?



## Method – 'testing' the framework

### Case study & mixed methods approach: focus groups, firm insights and semi-structured interviews:

Stage	Who?	What?
One	5 x case study customers (demand)	Identify supply/demand attributes, market gaps
Two	22 x case study SME manufacturers: Geelong (VIC), Newcastle, Wollongong (NSW)	Explore firm's strategies, capabilities, barriers, attributes
Three	3 x external stakeholder groups in each region	Insights from government/community decision makers, key concepts and policy efforts

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## 'Preliminary' Newcastle Insights

- 8 Manufacturers interviews
- Employ between 24-700 (across Aus.)
- Exploring:
  - Business insight
  - Value/Supply Chain Links
  - Sustainable Transition (attributes & challenges)
  - Business Development
  - Regional links & collaborations
  - The future

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## 'Preliminary' Newcastle Insights

Attributes	Challenges
All seeking value add opportunities (sustainability driven by customer or internal i.e. lightweight materials to wave energy)	Need cultural and technology shifts Is the customer asking for 'sustainability'?
Sustainability not seen as an extra – but a value add (unsung heroes, already doing it – operational & product development)	Lack of environment/sustainable agenda in Australia
Proximity of Trades	Timeframes to collaborate with research institutions
Globally diversifying v divesting	Limited skills and capabilities to make transition Employ on attitude and train
Partnerships with start-ups or other	Policy impediment – incentives, structure, level playing field, marketing capability
Customer focused v problem focused	Partnerships – attitude to collaborate
Focus and build on core strengths	Knowledge – industry advocates
Gen Y driving change	

## Aim of Focus Group

- Understand key concepts, evaluate current policy efforts and strategies that contribute to industry capability building and regional transitions towards a **sustainable** economy
- Focus Group in each region
- 5 themed areas

## Appendix E: Focus Group questions addressing aim and research themes

### Focus Group Format – External Stakeholders

**Aim:** Understand key concepts, evaluate current policy efforts and strategies that contribute to industry capability building and regional transitions towards a sustainable economy.



Main Question Theme	Description – Sub questions?	Aim of Q	Time
Understanding Sustainable Transition?	Quickly write three things that come to mind when you think of a 'sustainable economy/transition'	Gain a clear picture of external stakeholder understanding of what a sustainable transition is in this context	5 mins
	Quickly write three things you think are driving the need for a transition  Discuss above two points as a group	Gain an understanding of the key drivers for a transition  (ICEBREAKER)	10 mins
Why manufacturing?	What are the current challenges facing the Australian manufacturing sector today?  What are the current opportunities facing the Australian manufacturing sector today?	To build a picture of the views of Australian manufacturing from different agency perspectives	10 mins
Manufacturing Policy Strategies	What strategies are being employed by your region/agency to assist the manufacturing sector access these opportunities and deal with these challenges? What could be done differently?	To gain an understanding of the agency response to assist the manufacturing sector	10 mins
Sustainable Transition Policy Strategies	What are the future opportunities for regional manufacturers in a sustainable economy and how do they get there?  What is needed from government/your agency/your region to assist manufacturing industry to transition towards a sustainable economy? i.e. institutional engagement, networking forums, planning, funding, case studies, clusters, etc.	To gain an understanding of the agency response to assist with a sustainable transition	15 mins
The Future	Is there a collaborative agenda for change in the region? What are the policy/organisational, structural barriers to change?	To get an idea of next steps and the commitment required	15 mins
	How can we influence policy change towards sustainable transitions? Other comments?		

### **Semi-Structured Interview Questions – Customer**

#### **Aim (for researcher's purposes only):**

To ascertain value/supply chain mechanisms, current project development opportunities, future supply chain needs, attributes that determine supplier choice, demand attributes for sustainable products and services (now and into the future) and what elements will they look for in Australian manufacturing particularly, market gaps and opportunities that regional manufacturing sectors could fulfil.

#### **Customer Details (for each interview collect the following):**

Customer/Organisation name:

Contact details; address, email, phone, website

Interviewee name & position:

Date of Interview:

#### **Section A – Customer/Demand Insights**

1. In what year was your organisation established?
2. How many people does your organisation employ?
3. Please describe the core business of your organisation?
4. Please list the industry sectors where your services/outputs/products are distributed (e.g. sustainable building, waste, water, clean energy, environmental services, medical, defence, etc.)
5. What growth opportunities or changes in value chain do you see for your business? Provide list that includes: growth in existing markets/products, new market development for existing product, market development for new products/services, new business processes, export opportunities (if so, location), sustainable economy business opportunities, sustaining business only

#### **Section B – Sustainability**

6. How do you understand sustainability?
7. Does the sustainable/low carbon economy offer existing or future business opportunity for your organisation?
8. Where do you see your competitive advantage in the sustainable economy?
9. What are your challenges operating and driving sustainable business activity in Australia?
10. How do you overcome these?

#### **Section C – Value/Supply Chain Linkages**

11. Is your organisation currently undertaking any activities that involve collaborating with other organisations to achieve its sustainable business functions? If yes, provide detail
12. What proportion of your total procurement value comes from the areas of Geelong, Wollongong or Newcastle, Sydney, NSW other, other Australian location, International? Provide detail
13. Do you consider sustainability when procuring supply chain services? If yes, what priority? Provide detail.
14. What are the capabilities/sustainable qualities/criteria that you as the customer look for in your supply chain? i.e. price, responsiveness, materials, processes, quality
15. Are there any sustainable business development/growth opportunities which you cannot meet due to supply chain issues, capacity, capability or skills constraints, impediments or barriers to entry?
16. What are your future supply chain needs?
17. Are there gaps in your supply chain? If so, where and how would you ideally like to fill these?

18. What do you see are the impediments to sustainable supply chains in the manufacturing sector?
19. How do you measure sustainability in your supply chain?
20. What do you think are the key attributes within your current supply chains?

Other comments...

## **Identifying attributes of a sustainable transition for traditional regional manufacturing industry sectors – a conceptual framework**

### **Abstract**

Traditional manufacturing industry is facing significant transformation. Fundamental to this transformation, are the challenges of a changing social, economic, political and environmental future in response to climate change, global competition and limits to finite resources. These challenges have motivated a transition towards a new sustainable trajectory. Within a range of disciplinary fields, scholars have studied and developed conceptual frameworks to explain the processes, outcomes and effectiveness of particular transitions. Yet, there remains limited evidence drawing together these conceptual approaches to identify the elements and attributes essential to holistic, practical and long lasting transitions within established manufacturing regions. To address this gap, this article introduces an interdisciplinary framework, ‘Attributes of a Sustainable Transition’, by reviewing and integrating four existing conceptual approaches. These include, Advanced Manufacturing, Sustainable Transitions, Regions are Spatial and Transition Regions, to identify attributes of a sustainable transition within the manufacturing industry sector. In the process, this article also focuses on regions as important spaces for transitions, an emphasis currently missing from traditional economic approaches. Examples from international and Australian case studies are used to support the conceptual analysis, paving the way for future empirical research based on Australian firms.

Key words: Manufacturing, Industry, Sustainability, Transition, Region.

## **Insights into a sustainable transition of the traditional manufacturing sector**

### **Abstract**

The decline and transformation of traditional manufacturing in many developed countries has been well documented. Fundamental to this transformation are the challenges of a changing social, political, economic and environmental future in response to climate change, globalisation and limits to finite resources. However, addressing these concerns within current economic frameworks continues to fall short of the long term vision needed to reshape the way industries are configured towards a sustainable economy. Nevertheless, manufacturing firms in the traditional construction, chemical, heavy engineering, machining and metal industry sectors have begun to acknowledge the need to change and embrace innovative and sustainable operations. This article aims to contribute to the literature on sustainable transitions, by examining the nature and course of this evolution through the lens of manufacturing firms and refining the theoretical basis within an Australian context. Through examination of the attributes of a sustainable transition in 24 firms in traditional manufacturing settings, this article highlights the application of two conceptual approaches – Advanced Manufacturing and Sustainable Transitions. These theoretical building blocks and practical design considerations provide a starting point for policy makers and manufacturing firms seeking to stimulate transformative change.

Key words: Manufacturing, Sustainable, Transition, Industry, Innovation.

## **Transitioning a manufacturing region – a spatial insight**

### **Abstract**

The weakening of the traditional manufacturing sector across global city regions and the subsequent industry reconfiguration in place have been largely overlooked within the field of transition studies. Such fundamental change is compounded by a shift towards a lower carbon future, where sustainable production systems are contested within the environmental, social and economic value chain. This empirical study aims to build upon transition and evolutionary economic geography studies in order to analyse the transformational challenges and spatial attributes of 24 traditional manufacturing firms in three Australian city-region contexts. This article examines how and why specific sustainable transitions take place across different regional geographies.

Key words: Manufacturing, City Region, Spatial, Sustainable, Innovative, Transition.

## **Interfirm customer-supplier collaboration for a sustainable transition**

### **Abstract**

The transition literature has so far paid little attention to the role that interfirm customer-supplier relationships might play in sustainable projects. This article draws on contributions from technological innovation systems and sustainable collaboration literature to examine whether and how collaborations between the customer-supplier in a traditional manufacturing context can influence a shift towards a sustainable transition. An analysis of four cases of collaborations between the supplier (manufacturer) and the customer (original equipment manufacturer or OEM) highlight that a collaborative alliance can indeed influence a shift of the traditional manufacturing mind-set. By blending regional and extra-regional proximity, this transition is achieved by employing seven key resource formation processes: a direction and vision for sustainability, knowledge creation and diffusion, market-niche formation, resource investment, creation of legitimacy, demand articulation and policy coordination.

Key words: Sustainable, Transitions, Manufacturing, Customer, Supplier, Collaboration.



**AIRRANZ 2015**

**NON REFEREED ABSTRACT**

**Stream: Developing Sustainability Strategies**

**Paper Title: Identifying attributes of successful sustainable transitions for traditional manufacturing industry across regions in Australia**

**Katrina Skellern, Professor Ray Markey, Dr Louise Thornthwaite** (Centre for Workforce Futures, Macquarie University)

**Abstract**

The developed world is witnessing significant challenges as it experiences a changing social, economic and environmental future as a result of climate change, a shift in economic growth patterns from traditional industrial production to advanced, high-value models and the combined effects on local and regional communities. This acknowledgement has triggered a transition conversation towards a new sustainable trajectory, the problem, however, is that the actualisation of sustainable alternatives struggle to compete with dominant traditional ‘growth at all costs’ economic ideologies.

Over the last five years, sustainable transitions have been explored within a range of singular studies, frameworks, models and theories but there is limited evidence drawing together these approaches to identify elements and attributes to successful, practical and long lasting transitions.

Firstly, this paper will introduce an interdisciplinary framework ‘Attributes of Sustainable Transitions’ that extends on four existing conceptual approaches to generate new knowledge in identifying the attributes of successful transitions in manufacturing regions of Australia as well as addressing a gap in the literature. Secondly, this paper will focus on why regions in Australia are important spaces for transitions and have been missing from traditional economic approaches to open up the spatial and relational context of the region towards a new sustainable trajectory. Finally, this paper will offer an Australian perspective on sustainable transitions with global significance and appeal. Much of the research to date has been undertaken outside of Australia and New Zealand where the economic, geographic, political, cultural, environmental and social conditions are considerably different.

**International Sustainability Transition Conference**

**6 - 9 September 2016, Wuppertal Institute, Germany**

**Speed Talk Session: Insights into a sustainable transition of the traditional manufacturing sector**

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The decline and transformation of the Australian manufacturing sector has been well documented. Fundamental to this transformation are the challenges of a changing social, economic and environmental future in response to climate change, global competition and limits to finite resources. However, addressing these concerns within current economic development and policy frameworks continues to fall short of the long term vision needed to reshape the way industries are configured towards a sustainable economy. Nevertheless, traditional manufacturing firms are beginning to acknowledge the need to change and evolve towards a sector that is deemed high value, engages meaningfully with its workforce, is customer focused, collaborative, innovative and sustainable. How to actually make this transition is the case in point.

Over the last decade, research has explored sustainable transitions within a range of singular studies, theoretical frameworks and models but there is limited evidence drawing together these approaches to identify elements and attributes to successful, practical and long lasting transitions with a focus on ‘traditional’ manufacturing sectors. By applying an interdisciplinary conceptual framework, ‘Attributes of Sustainable Transitions’, this paper aims to contribute to this transition enquiry, knowledge base and gap in empirical research. Rather than considering the elements of one conceptual framework in isolation, the Attributes of Sustainable Transitions framework draws together four existing conceptual approaches (Advanced Manufacturing, Sustainable Transitions, Spatiality of Regions and Transition Regions) to identify elements and attributes that effect successful sustainable transitions. The paper identifies and examines the elements associated with sustainable transitions within twenty four firms in traditional manufacturing settings in regions of Australia.

This approach is innovative in integrating four existing conceptual approaches into a cohesive new framework, exploring shifts within the socio-technical system to redefine manufacturing in a new sustainable economy and stimulating radical shifts in technological and non-technological innovation.

First, rather than traditional manufacturing concentrating on the production side of things, an advanced manufacturing approach encompasses the whole chain of activity from research and development to end of life management, opening up opportunities for productivity performance, skill development, value add and market development.

Second, a sustainable transition approach requires new environmental problems to be analysed at the social as well as the technical level, considering the existing system as well as the societal domain in which an organisation operates. Third, a focus on why traditional manufacturing regions in Australia are important spaces for transitions has been missing from traditional economic approaches to open up the spatial and relational context of the region towards a new sustainable trajectory. Fourthly, a transition region approach validates the significance of the spatial lens in transitioning to an advanced manufacturing model and promotes a need to understand the path dependent, related variety and proximity elements for regenerating the traditional manufacturing sector. If sustainable transition pathways are to be successful, industry and regions need new techniques as well as product accumulation to succeed. Finally, this paper will offer an Australian perspective on sustainable transitions with global significance and appeal. Much of the research to date has been undertaken outside of Australia and New Zealand where the economic, geographic, political, cultural, environmental and social conditions are considerably different.

This paper suggests that the proposed conceptual framework will provide a lens through which to explain the following: first, the existing and emerging elements of sustainable transitions for traditional manufacturing industries in regions of Australia; second, which elements have the greatest influence and contribute to the development of new knowledge and learnings for successful transitions.